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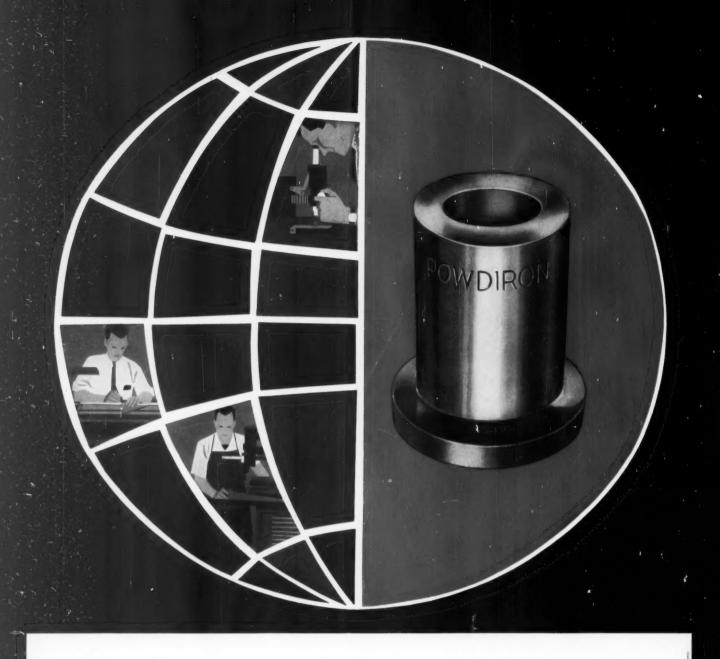
High-Pressure Hydraulics

Contents, Page 3

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MR, STEVENS RICE 313 N. FIRST ST. AND ARBOR, MICH.



New Alliance-New Processes-New Economy

From Bound Brook's newly-formed association with the world-wide organization of Birfield Limited, comes the new Ferrocite process—making possible economies of operation never before available in self-lubricated iron bearings of Bound Brook quality. The high standards of Powdiron[®] quality have been retained, but the resultant economies make Bound Brook your best buy in iron bearings. The next time your specs call for self-lubricated iron bearings, it will pay you to call Bound Brook.

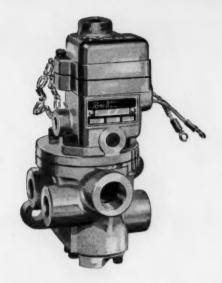


BOUND BROOK BEARING CORPORATION OF AMERICA

A BIRFIELD COMPANY

Pioneer in Powder Metallurgy Bearings and Parts • Plants at Bound Brook, N.J. and Sturgis, Mich.

Circle 201 on Page 19



this small valve can do a big valve's work

Ross

NEW "HEADLINE" SERIES

This story has made the Ross Headline valve series a "standard" in the world of valvedom in just six short months. There is nothing "exotic" about it. Our designers and manufacturing engineers have simply been able to create an economical inline valve that will pass a greater volume of air, valve size-for-valve size, than any other valve made. The Headline valve thus in many instances permits you to use a

smaller valve than you could use before. Since this has been done without compromising Ross traditional quality, and long-life is thus taken for granted, the "Headline" series then represents probably the best valve value available today. Straightways, 3-ways and 4-ways. Pipe sizes, ¼" through 1½".

Call your Ross representative or write for Bulletin 323.

For other Ross valves see our catalog in Sweets Product Design File.

ROSS OPERATING VALVE COMPANY

109 EAST GOLDEN GATE AVE. . DETROIT 3, MICHIGAN





Front Cover: Up and out of sight go the numbers in George Farnsworth's "high-pressure system." Author Russ Henke tells us what it's all about, starting on Page 140.

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COPPER FOR CONDUCTIVITY TEAMS UP WITH STEEL FOR STRENGTH



...in a compact, low-maintenance conductor system for heavy-current industrial applications

The copper-headed steel conductor rails, shown above, of the Ringsdorff Carbon Corp., East McKeesport, Pa., help provide many economies in con-

The heart of the Ringsdorff Current Conductor System—the copper-headed steel conductor rail and pantograph current collector with a graphite carbon shoe. Components, including rail hangers and joints, are available in a wide variety of sizes, with capacities up to 2000 amps, for either a-c or d-c systems

ductor systems for such heavy-current users as traveling cranes, ore bridges, monorails—using either a-c or d-c.

The system is simple and compact. One basic steel shape provides strength and simplifies installation. Over it is cold drawn the copper head of extruded Anaconda ETP Copper-100, in the size to meet individual current requirements. (Copper-headed conductor rail, left, 500 amps; right, 1500 amps.) Less space is needed; installation is easier than with aluminum rails.

Long life and low maintenance. The special Ringsdorff carbon graphite used in sliding contacts has an affinity to copper, putting down a film that lubricates its passage and protects the rails. Wear on the copper head is negligible over periods of 20 to 25 years. Only

maintenance is replacement of carbon shoes, having an average life up to 3 years. Aluminum rails must be protected by lubrication or they will wear and pit—when out of use for a period may develop an insulating oxide film.

This is another illustration of the way the unique properties of copper are being utilized in industry to do things better—at lower cost. Anaconda has teams of specialists available to sit down with members of your organization to help select the alloys and forms of metal to solve your value analysis problems. For such technical help, see your Anaconda representative, or write: Anaconda American Brass Company, Waterbury 20, Conn. In Canada. Anaconda American Brass Ltd., New Toronto, Ontario.

ANACONDA

COPPER BRASS BRONZE NICKEL SILVER MILL PRODUCTS

Anaconda American Brass Company

Circle 206 on Page 19

DESIGN

ENGINEERING NEWS

Water Ponds Brake Runaway Jets



Water-pond arresting gear is of particular interest for civil aircraft because it requires no modifications or attachments to the airplane and no mechanical devices are needed in the arresting system. The test pond was scaled to simulate a body of water 150 ft wide by 1000 ft long. Water depth was equivalent to 3 ft. A full-size transport entering the water at 100 knots would stop within 950 ft.

Langley Field, Va.—Jet aircraft that try to land too fast or are forced to abort on take-off may someday come to rest in shallow water ponds. Tests show a pond, located at the end of a runway, does a good job of stopping an airplane that can't halt on its own. And unless speed is quite high, there is little or no damage to equipment.

The test program, conducted at NASA's Langley Research Center, involved both openwater and plastic-covered ponds. A dynamic scale model of a jet transport, "taxied" on the Center's monorail system, entered the water at scale speeds of up to 100 knots. At top speeds, damage occurred to landing gear (from drag force) and to the inboard flaps when they were down (from spray), but the model showed it could survive most of the test conditions.

No indications of yawing or other steering instabilities were observed, except those which could be traced to asymmetries in the model or in the water pond. Overruns in the water were considerably longer than those on the plastic cover. There was no water damage with the plastic cover, although at high entry speeds, drag force caused the landing gear to fail.

Engineer Employment Market Shows Long-Term Shrinkage

Job Openings Halved In Five-Year Period

New York—Although the number of engineers looking for new jobs has remained about the same, openings are "off" 36 per cent since 1959-60. Worse, during the last five years, employment opportunities for engineers have dropped to half the earlier levels. These statistics come from Alfred H. Meyer, director of Engineering Societies Personnel Service (a joint activity of the engineering societies), and were reported in the latest issue of Engineer, published by Engineers Joint Council.

The slight recession in engineer-

ing employment is spotty, Mr. Meyer continued. In the electronics industry there are numerous positions available with few applicants, while in the electrical-power field there are few vacancies. In the mechanical and manufacturing fields, the foods, paper, and electric motor industries are actively hiring, but machine tool, steel, and automotive companies are not expanding.

"In spite of the fact that this does not seem an optimistic report, the general feeling is that for the balance of 1961 the employment market for engineers, on the whole, will greatly improve." In addition, fewer freshmen are taking engineer-

ing—the actual number of engineering students entering the colleges has fallen from 78,750 in 1957 to 67,550 in 1960. Unless the pattern of transfers and retention rates changes dramatically (and there is little reason to believe it will), the supply of engineering graduates will be at or below the present level of 37,500 for the next four to six years.

The over-age engineer is still a serious problem in spite of all the federal and state rules on discrimination against older men. Industry, apparently for valid reasons, persists in recruiting younger men, while most consulting-engineering firms prefer the experienced older ones.

.. Fluid Power NEWS



Years of Fluid Power

Report No. 11,806 From Ollgear Application-Engineering Files

HOW OILGEAR HEAVY-DUTY Any-Speed HYTAC* DRIVE SYSTEMS ON Anaconda's NEW FOIL LAMINATING AND COATING MACHINES HELP SPEED PRODUCTION—CUT COSTS

USER: The Anaconda Aluminum Company, Louisville, Kentucky, Fair Lawn, New Jersey, Terre Haute, Indiana (Machine Builder — New Era Manufacturing Company, Hawthorne, New Jersey — successor to Meisel Press Manufacturing Company, Boston, Mass.)

PROBLEM: Main and Rewind Drive Systems for two, new, high-speed laminators to bond aluminum foil as thin as 0.0002" to paper stock ranging from 15-lb tissue to 0.020" carton and food board. In addition to laminating, these "presses" must simultaneously coat and/or color the foil.

REQUIREMENTS: 1. Accurate, wide range, dependable tension control to accommodate Anaconda's complete range of laminating foils and paper stock. 2. Infinitely variable, stepless speed range from 0 to 1000 fpm—cap-

able of an optimum, continuous 850 fpm running speed.

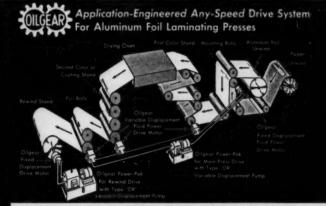
3. Maintain tension accurately in "stall" condition indefinitely without overheating—and then pick up speed smoothly and quickly without snapping the sometimes fragile web. 4. Reduce costs through reduction of scrap, repair parts inventories, and machine downtime... operate at nearly three times former production speeds.

5. Must be: compact, to conserve valuable floor space; economical on electric power input; capable of continuous, three-shift operation.



ABOVE: One of Anaconda Aluminum's new, Oilgear-equipped, high-speed foil laminating and coating presses—rewind end—as installed at their Louisville, Kentucky, Laminating Plant, Roll cores—8¾ dia. . . . web width—from 23° to 52° . . roll diameters—to 60° . . roll weights—to 4500-lb. Tension range —from ½-lb/in. to 4-lb/in. depending on weight of lamination being processed. Arrows (A), (8)—Oilgear Variable Displacement Drive Pumps. Arrow (C)—one of two pushbutton control stations at opposite ends of the press—3 emergency "stop" buttons are located at other positions.

SOLUTION: Oilgear Any-Speed HYTAC* Main and Rewind Drive and Tension Control Systems—as symbolized in the schematic sketch-above right. These compact, heavy-duty systems have successfully met or exceeded all originally specified requirements in continuous, three-shift, high-speed operation. Oilgear Drives were selected for these new machines because of: 1. The enviable record of maintenance-free long-life in several Anaconda Aluminum Plants. For example - six out of seven original, 300from laminating presses at Louisville are Oilgear-equipped ... two operating continuously since 1946. These 14year-old drives - and two others - have NEVER required maintenance other than oil changes and an occasional drive shaft seal. The other two Oilgear Drives-installed in 1948—were disassembled three years ago merely for a preventive maintenance check—haven't been "touched" since. 2. Oilgear's accurate, dependable tension and speed control over a wide range-for smooth, precise, troublefree operation on Anaconda's entire range of laminating stocks. 3. Space saving-Oilgear Drives occupy less floor space . . . do not require high-speed blowers for coolingcan hold stall-speed indefinitely without overheating. 4. Economy—in electrical power input, maintenance, virtually eliminate costly machine downtime and spare parts inventories . . . and in many cases—at lower installed cost.



*HYTAC -- A legislered Dilgear Trademark

Unbelievable? — Not to Oilgear Users! There are case histories upon case histories on file of machines equipped with Application-Engineered Oilgear Drive Systems that are rolling along—efficiently, quietly—with over 20 years of trouble- and maintenance-free service! Some additional installation-proved reasons . . . the greater accuracy, precision control of speeds, torques, tensions . . . new economies of operation, installation, and valuable floor space . . are why more and more Oilgear users in the paper, printing and converting, food and beverage, marine, chemical, pharmaceutical, primary metals, metalworking, textile, rubber, military, and other industries all agree that . . .

for the lowest cost per year . . . it's OILGEAR!

For practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

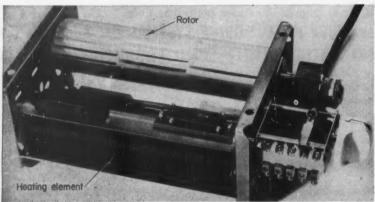
THE OILGEAR COMPANY

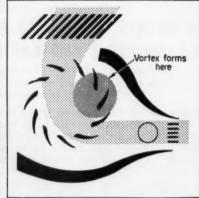
Application-Engineered Fluid Power Systems

1568 WEST PIERCE STREET . MILWAUKEE 4, WISCONSIN

Phone: Mitchell 5-6715 . . . Direct Distance Dialing Code - 414

Low-Speed Fan Delivers High-Velocity Air





Air moves air in a new type of fan-driven heater designed in England. The device sets up a vortex inside its rotor. Stabilized between air inlet and outlet, the vortex rotates at high angular velocity with its center very near the inner edges of the rotor blades. Spinning in the same direction as the rotor, this whirlpool entrains inlet air, speeding it up and pulling it past the fan blades at a higher velocity than the peripheral speed of the blades themselves. According to the Solatron Electronics Group Ltd., Farnborough, Hants. (manufacturer of the heater), air goes through a double traversal of the blades, reportedly giving the fan more output per unit frontal area than any other type. Advantages

claimed for the high-air-velocity, low-blade-speed combination include exceptionally low noise levels (noise varies with the 5.5 power of blade speed) and lack of turbulence in the outlet air. The heater is reported to blow a laminar beam of warm air 15 ft into a room without the beam breaking up because of convection currents. Spokesmen for SEL claim the new fan principle overcomes previous limitations of poor efficiency in small, comparatively slow-moving fans. It achieves, at low Reynolds numbers, performance characteristics that were previously possible only with high Reynolds number flow, i.e., with a large product of blade chord and peripheral speed.

Crushing Plant Goes to the Quarry



Mobile limestone crushing plant, developed by Fried. Krupp, Rheinhausen, Germany, eliminates expensive and laborious rail haulage by breaking up the limestone at the quarry. The machine first reduces the stone to a suitable size for handling, and then feeds it, via a rubber-belt conveyor, into the grinding plant. Units built so far are capable of crushing lumps up to 24 in. at a rate of 250 tons per hr. The plant consists of a feed hopper, apron feed conveyor, single-shaft hammer mill, and an apron discharge conveyor, all mounted on a common crawler. Feeding is done by a power shovel.

Standards Makers Plan Specs For Control Computers

New York—Standards work in the fields of numerical control of machine tools and process-control computers will begin later this year. Recommended by 12 associations, the study must be approved by the Miscellaneous Standard Board of the American Standards Association prior to the appointment of a committee to develop the standards.

The project will be concerned with the standards for measurement and specification of electrical and physical characteristics of components used in computers and numerical-process controls. Specific tasks to be undertaken include:

 Industrial-process control—develop ways for specifying analogdevice sensitivity

 Machine tool numerical control develop standard codes for feeding information to machines.

 Input-output—work up methods for the measurement and description of characteristics of media such as cards and tape.

greatest capacity for the UNKNOWN SHAFER-REX Self-Aligning Roller Bearing

When you specify a bearing, you can't tell how long it will last beyond its rated load capacity and normal service life.

Nor do you know whether neglect or severe conditions might cut bearing life short—resulting in customer dissatisfaction, justifiable or not.

Yet, the reputation of your equipment might depend on how the bearing meets the unexpected.

The safest way is to specify the bearing that meets the most critical requirements for maximum bearing life—the Shafer-Rex Self-Aligning Roller Bearing.

For full information, write CHAIN Belt Company, 4643 W. Greenfield Ave., Milwaukee 1, Wis. In Canada: Rex Chainbelt (Canada) Ltd., Toronto and Montreal.





Shafer-Rex design eliminates additional wear and stress caused by misalignment. Due to the ball-and-socket interaction between the inner race and rollers, misalignment is accommodated by the inner race—it never reaches

the rollers. Whether the load is misaligned or not, rollers never tip. They remain in the aligned position, assuring equal load distribution through the center of each roller at all times.



Shafer-Rex design takes severe shock and loading safely. Rollers are concave; raceways are convex with a slightly smaller radius. This allows minimum contact between roller and raceway surfaces under normal loads. Under shock or heavy

loads, this design permits the bearing surfaces to compress safely, increasing the load-bearing area to meet excessive load requirements without damage or excessive wear.



Shafer-Rex design takes thrust loads without strain or binding. Shafer-Rex Concave Rollers are self-centering. This, combined with ball-socket design, allows the most severe thrust loads or radial-thrust loads to remain safely centered on the rollers

-eliminating roller end-wear-eliminating the need for a guide flange, a common source of wear.

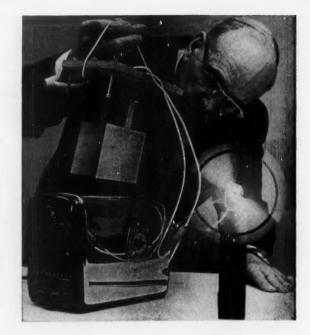
The Austin Effect: First Step Toward a New Power Source?

Lima, Ohio—Researchers at the Aerospace Dept., Westinghouse Electric Corp., have found a new way to convert heat to electricity, but they don't know why it works.

Power to drive a small motor and propeller is produced when two thin plates are heated, like slices of bread, in a toaster (photo). The specially prepared plates—an iron base metal is covered with porcelain enamel, which in turn is covered with a thin layer of silver—each produce power densities of up to 16 milliwatts per sq in. when heated to 1200 F. Iron acts as the positive pole, silver as the negative.

The effect, discovered by Westinghouse consultant B. O. Austin, has only been observed in the one type of metal-ceramic sandwich. Because it can operate at high temperatures, the device appears promising for missile and space applications. Westinghouse is sponsoring research at Battelle Memorial Institute to determine basic principles of the phenomena and develop materials

with improved output characteristics.

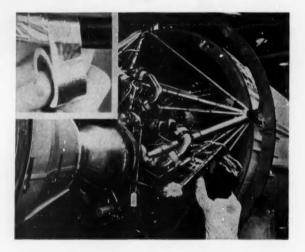


Tape Reflects Rocket Heat

St. Paul, Minn.—Missile parts protected with a new heat-reflecting tape won't be bothered by searing blasts of radiant heat from rocket engines. Developed by Minnesota Mining and Mfg. Co. especially for missile and aircraft applications, the glass-cloth/aluminum-foil tape can perform continuously at 600 F and can withstand temperatures in excess of 300 F for short periods.

According to 3M engineers, the tape shows promise in less glamorous jobs as well:

- It's a superior reflector of infrared radiation.
- Easy to handle, it is durable enough for spiral wrapping with no damage to reflectance.
- It is exceptionally flexible, and can be quickly and permanently adhered to irregular, curved shapes.



Superconducting Wire Has Zero Resistance

Coreless Magnets Possible
At Cryogenic Temperatures

Canoga Park, Calif.—A new superconducting material, developed by Atomics International, division of North American Aviation Inc., has "zero" resistance to electrical currents. Wire drawn from the material conducts a current of 100,000 amp per sq cm in a moderate magnetic field (30,000 gauss) at liquid-helium temperature (-452 F). Performance of this wire can be roughly equated to the operation of a house-hold appliance at about 100,000

watts from a conventional 110-v outlet, according to AI.

The new superconductor is a coldworked alloy made up of approximately three parts niobium to one part zirconium. The alloy is malleable and strong, and it can be formed into wires that are easily coiled, bars, strips, and other shapes. Forming doesn't alter the superconductive properties of the material.

Because the alloy is expected to retain the same characteristics in substantially higher magnetic fields, the development makes it possible to design superconducting magnets to replace bulky and relatively inefficient iron-core electromagnets. The superconducting magnet has no iron core and it can produce magnetic fields many times higher than conventional electromagnets.

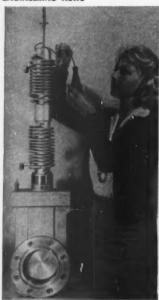
Use of superconducting magnets of 100,000-gauss strength for highenergy particle accelerators or controlled thermonuclear research devices could substantially reduce operating costs. Similarly, superconducting magnets may be particularly important in space technology where light-weight magnets are needed. Such magnets could store more electrical energy in less space than conventional capacitors.

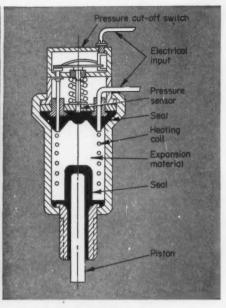


Aluminum Island.

Is this tomorrow's marina? The boat company that commissioned this Olin design thinks it's very likely. After all, new design and engineering concepts and new fabricating techniques make aluminum near limitless in application. Aluminum's inherent qualities, resistance to corrosion, lightness, natural attractiveness and strength make it a "dream medium" for designers; this marina is an excellent example. It's an on-the-spot depot for fuel, food, marine supplies — and travels from place to place under its own power. And designers who work in new concepts of aluminum have the resources of Olin Aluminum at their disposal. Our technical research and product development staff live in the world of new alloys, intricate design, fabrication, and cost and production statistics. They "think aluminum." All you have to do is think "Olin." A







Expanding Wax Drives High-Force Heat Motors

Small and compact, new electrothermal actuators developed by Standard-Thomson Corp., Waltham, Mass., provide forces from 30 to 200 lb (up to 500 times their own weight), and strokes from ½6 to 6 in. Heat is supplied by an integral electric-resistance heater immersed in a fluid or wax within the unit. Pressure developed within the actuator, as a result of thermal expansion of the fluid, is transmitted as a force to the piston through a synthetic elastomeric seal. Power packages are being developed by STC to produce linear, rotary, and positioning devices for applications that do not require instantaneous response speeds. One power pack has already been adapted to operate a 6-in. gate valve (left) used in the vacuum freeze-drying of shrimp. Zone control valves for heating and cooling systems have also been developed.



Ordinary Tape Recorder Answers the Phone

Two sound tracks on a conventional magnetic-tape recorder accept and record incoming telephone calls in a new system designed by Telefunken GmbH, Hannover, Germany. An electronic control box that connects to both the recorder and the telephone accepts the call and starts the tape. The first sound track plays back to the caller, telling him what phone number he has called and that nobody is at home. The first track also informs the caller that he has 30 sec to dictate a message. The message is recorded on the second track, then, after the 30 sec, the first track thanks the caller and signs off. Up to 80 calls may be received on a single, standard-length tape.

Topics

White sidewalls with color—a stripe in the middle of the white—are available from Goodyear Tire & Rubber Co. The color band may be selected to match the car's upholstery or trim. Like some of the recent innovations in automobile interiors, the new tire design is attributed to the growing interest and influence of women in car styling.

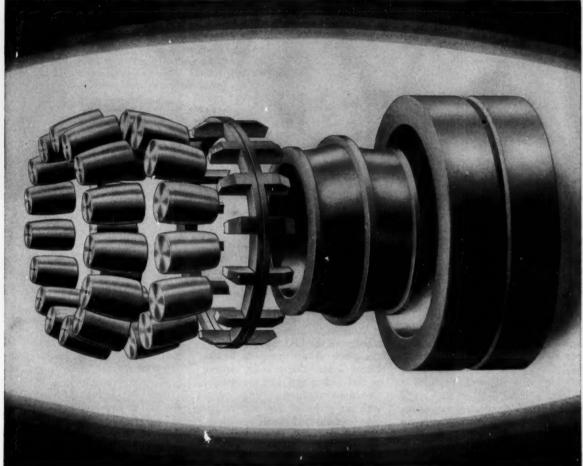
A vacationing V.I.P. will be able to keep in touch with his business affairs by means of a computer console only slightly larger than a portable radio come the 1970s. According to John L. Burns, president of Radio Corp. of America, such a gadget will place an executive's master data processing system as close as the nearest telephone outlet. All he will have to do is plug in and dial a code number, and he will be able to carry on his daily work routine.

Around-the-world television comes a step nearer realization with the development of an electronic converter by the American Broadcasting Co. Heretofore, a kinescope (photographic process) has been used to convert a program for broadcast outside the country in which it originated; this method caused delay and loss of picture quality. ABC's new converter will transform videotape or picture signals directly.

Possibilities of electrical shielding against radiation is being investigated by General Electric's space sciences laboratory in Philadelphia One way in which electricity could be used for this purpose is in the form of a "cocoon" around a space vehicle. This lightweight shield would deflect radiation in much the same way that the earth's magnetic field deflects cosmic rays.

Hi-fi heartbeats are being put to use in detecting and diagnosing heart ailments of schoolchildren. In a twoyear test in Chicago, 33.000 children were examined by recording less than a minute of individual heart sounds. About 90 per cent of children's heart disorders produce unusual sounds, and a doctor listens for such irregularities when he plays back a tape. On equipment carried in a house trailer, 250 children were recorded a day; listening and preliminary diagnosis was at the rate of 140 a day. It is thought that eventually computers will be able to examine the tapes and pick out the unusual cases for study by a physician.

TORRINGTON



FOR THE INSIDE STORY...

...ON TORRINGTON SPHERICAL ROLLER BEARINGS, one word: *precision*. Each individual part is precision-engineered to the highest standards in the industry...functions precisely and efficiently with all other parts.

Every roller is matched electronically within .0001" for even-load distribution and maximum capacity.

Each independent land-riding cage spaces rollers precisely...prevents roller drag even under the heaviest loads and possible misalignment.

The integral guide flange is ground to a common spherical radius with the roller ends for positive roller guidance, greater stability.

For minimum friction and wear, both inner and outer races are precision ground to conform exactly to roller contours.

Put together...a Torrington Spherical Roller Bearing for superior performance, reliability and long service life. Buy the best...specify Torrington.

SUPERIOR PERFORMANCE FEATURES OF TORRINGTON SPHERICAL ROLLER BEARINGS

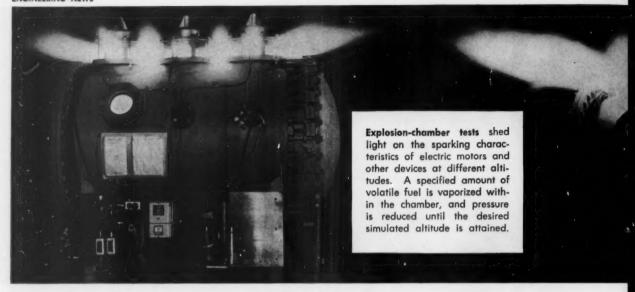
- inherent self-alignment
- conformity of rollers to raceways
- ☐ integral center guide flange for stability
- positive roller guidance
- ☐ land-riding bronze cages
- maximum radial and thrust capacity
- □ controlled internal clearance
- □ electronically selected rollers
- □ even load distribution
- □ long, dependable service life

progress through precision

TORRINGTON BEARINGS

THE TORRINGTON COMPANY

South Bend 21, Indiana . Torrington, Connecticut



For Vehicles: Made-to-Order Miseries

SwRI Packages the World's Worst Weather To Check Out Component Endurance

SAN ANTONIO, TEX.—Wearing effects of dust in machinery are becoming increasingly important, so the Environmental Research Section of Southwest Research Institute is taking a close look at man-made dust storms. Tropical, desert, arctic, and other extreme environments are also under study.

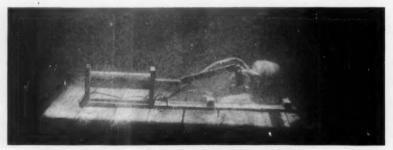
The primary job, according to Robert Engelhardt, chief of the section, is to predict just how much dust will be raised by military and civilian equipment. Once this is known, the next step will be to predict damage to equipment. To do this, the researchers will first have to evaluate abrasive properties of various kinds of dust. Presently, SwRI is working on wear rates for tank tracks operating in the Sahara Desert.

One of the most difficult problems the Army Ordnance Corps combats today is that of rapid equipment deterioration in a highly humid climate. Hard to control, humidity is slow acting in the damage it does, but its effects are severe. The environment specialists at SwRI are also active in this field, determining the effects of atmospheric pollutants acting in combination with high humidity.

Work in the tropics is the newest activity for the ERS. At the present time, one of the group is in the Canal Zone. The primary concern in this area is not with present-day Ordnance equipment, but rather with the problems that may be encountered in the future.

A reconnaissance program has been conducted to survey military operations in Greenland, and the effects of extreme cold on equipment have been evaluated. Storage methods, measures to prevent equipment deterioration, and operational techniques for military units located on the ice cap have all been investigated for the Ordnance Corps (the findings are classified).

Data on sand-storm composition has proved very useful to the Army. Valuable information has been derived on where to locate air cleaners and ventilation ducts on a vehicle, and analysis of dust clouds kicked up by a train of vehicles is teaching the Army how to scientifically space out a convoy.



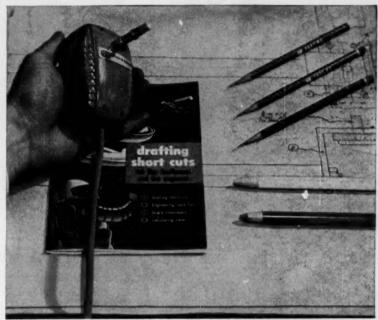
Salt-spray chamber, a rubber tank measuring 7 ft long by $2\frac{1}{2}$ ft high by 3 ft wide, uses no materials that would cause electrolytic corrosion. Salt fog is set up by two internal spray nozzles which produce a uniformly distributed fine mist. Circulating freely, the mist does not directly impinge on the test equipment. Rate of spray is controlled by needle valves at the nozzles. Highly humid air, necessary to atomize the salt solution, is obtained by passing compressed air through a heated water bath. Humidity is controlled by regulating air pressure and water temperature.





Dust concentration in the sand and dust tunnel is controlled by photoelectric cells located inside the test chamber. The electric signal generated is a direct function of the amount of dust cutting the light beam. Using a calibration chart, the test operator can quickly determine the exact dust concentration in the 18-cu ft chamber by cross referencing against the indicated signal. Control adjustment is manual. Temperature control of the chamber is accomplished by the use of two sets of baffles-one electrically heated, the other cooled by a refrigerant.

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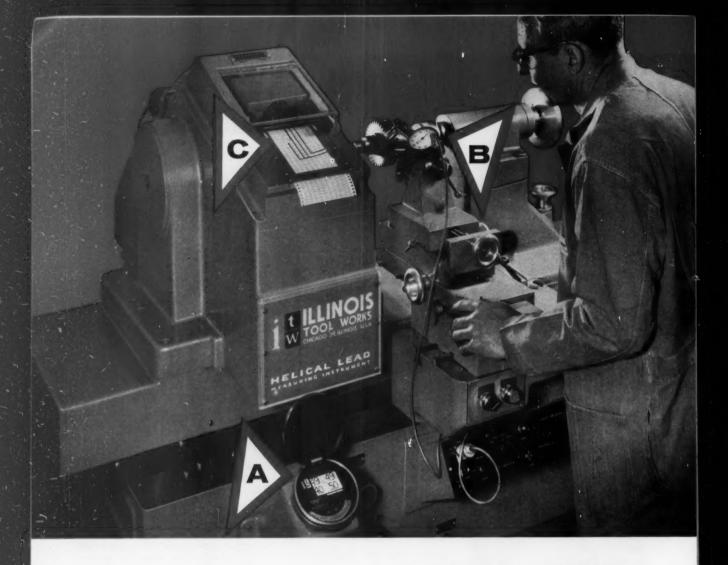
comfortable grip. Its three flat sides not only fit the controlling three fingers, but indicate to the draftsman a succession of 120° stops which help position the pencil for uniform line weight and density. Precise grading of lead hardness, plus colortip coding, further aid production of better tracings and clearer prints.

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Descriptions of items start on Page 196. Starred items are from June 8 issue.

Electrical, Electronic

- 501 Range Brives. 6 pp. U. S. Electrical Motors
- 502 Silicon Rectifiers. 6 pp. Semiconductor Div.,
- 502 Silican Rectifiers. 6 pp. Semiconductor Div., Roytheon Co.
 504 Thermometers and Gaues. 4 pp. Rochester Plant, Controls Div., American-Standard.
 514 Electric Meters. 12 pp. Brook Motor Corp.
 527 Centrol Instruments. 26 pp. Moore Products Co.
 537 Glass-Seeled Resisters. 4 pp. Victoreen Instrument Co.
 541 Control Switches. 30 pp. Henry G. Dietz Co. Inc.
 542 Metal-Clad Switcheser. 42 pp. General Electric Co.
 543 Printed-Board Connectors. 4 pp. Pos-E-Kon Div.,
 Thomas & Betts Co. Inc.
 599 Tachemeter Generaters.* Applications, calibration, accuracy, selection. Bulletin GEZ-3251,
 12 pp. General Electric Co.
 600 Polar Relays. Design, characteristics of Series

- Polar Relays.* Design, characteristics of Series PTW two-position units. Catalog 1821-E, 12 pp. Industrial Products Div., Automatic Elec-tric Sales Corp.

- pp. Industrial Products Div., Automatic Electric Sales Corp.

 601 Tharmeelectricity Developments.* Present and
 future uses, also covers Seejenator power package. 4 pp. Harco Loboratories Inc.

 602 Cemmarcial Thermestats.* Types A and AY
 snap-acting, fixed-temperature units. Bulletin
 3000, 4 pp. Stevens Mfg. Co. Inc.

 603 Custom Silip Rines.* Types available, features,
 technical data. Bulletin CON-14, 2 pp. Metals
 & Controls Inc., Div., Texas instruments Inc.

 604 Multispeed Chert Drives.* Step-function speed
 reductors, instrument drive systems, and multispeed chart drives. Bulletin 1281, 4 pp.
 Insco Co., Div., Barry Wright Corp.

 605 Silicom Rectifiers.* Three types of dc rectifiers
 rated 0.75 to 75 kw. Bulletin GEA-7066, 6 pp.
 General Electric Co.

 606 Germanium Transister.* Type 2N1289 germanium, NPN, high-speed unit, Publication 30,67,
 6 pp. Semiconductor Products Dept., General
 Electric Co.

 607 Certified Thermestats.* Type A thermostats for

- Electric Co.

 607 Cartified Thermostats.* Type A thermostats for electronic, avianic applications. Bulletin 3000-1, 4 pp. Stevens Mfg. Co. Inc.

 608 Mater Application Guide.* Single-phase, three-phase, and direct-current motors. Bulletin 010, 16 pp. Century Electric Co.

 609 Moldins-Magnet Design.* Simplified method for designing holding magnets and assemblies. 4 pp. Indiana Steel Products Div., Indiana General Corp.
- designing notating transfers.

 pp. Indiana Steel Products Div., Indiana General Corp.

 610 Instruments and Components.* Electrical connectors and headers, high-temperature insulation, magnet wire and cobles. Catalog FP-1-61, 4 pp. Packard Bell Electronics.

 611 Variable-Speed Drives.* Lube-free integral and fractional-horsepower drives. 112 pp. Sterling Electric Motors Inc.

- fractional-horsepower drives. 112 pp. sterring Electric Motors Inc. 612 Precision Resister.* Specifications on the Ro-tohmeter user-adjusted unit. Bulletin R-65, 4 pp. Rotohmeters Inc. 613 Mercury-Wetted Cantact Relay.* High-speed, Class V relay. Circular 1988, 4 pp. Industrial Products Div., Automatic Electric Sales Corp.

Hydraulic, Pneumatic

503 Liquid-Level-Gage Valves. 8 pp. Jerguson Gage 506 Centrifugal Pumps. 4 pp. Aurora Pump Div.,

- New York Air Brake Co.

 509 Hydraulic Products. 76 pp. Oll-Dyne Inc.
 510 Pluss, Chip Betecters, Valves. 26 pp. Lisle Corp.
 511 Retating Seal. 4 pp. Sealol Inc.
 513 Bellows, Bellows Assemblies. 20 pp. Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co. port Thermostat Div., Robertshaw-Fultan Con-trols Co. Miniature Check Valves. 30 pp. Spartan Mfg.
- Corp.
 319 Small Pumps. 4 pp. Moyno Pump Div., Robbins & Myers Inc.
 521 Plastic Prefectors. 8 pp. S. S. White Plastics
- 526 Pressure Saubbers. 4 pp. Chemiquip Co. 528 Pump Drives. 20 pp. U. S. Electrical Motors
- 533 Valves, Cylinders, Pumps. 6 pp. Airmatic Valve
- 335 Variable-Displacement Pump. 4 pp. Hydraulic & Pneumatic Sales, Weatherhead Co. 538 Electric Valve. 4 pp. Skinner Electric Valve Div., Skinner Precision Industries Inc.
- Div., Skinner Precision Industries Inc.
 544 Sight-Flow Indicator, 4 pp. Brooks Instrument

- Div., Skinner Precision Industries Inc.

 544 Sight-Flow Indicater. 4 pp. Brooks Instrument
 Co. Inc.

 614 Valves, Buffles, Traps.* High-vacuum equipment specifications. Bulletin 10-1, 28 pp. Consolidated Vacuum Corp.

 615 Cestrifusel Pumps.* High-pressure pumps with
 copacities to 2600 gpm for heads to 3400 ft.
 Bulletin 722-4, 8 pp. Goulds Pumps Inc.

 616 Relling Diaghreyms.* Design manual on friction-free units. 26 pp. Bellofrom Corp.

 617 Oil-Level Gages.* Flush-mounting Type 50
 gages, with 5, 7, 10-in. centers. 6 pp. Federal Brass Mfg. Co.

 618 Air, Hydraulic Cylinders.* Heavy-duty, 1½-in.
 square, clamp-type units. Bulletin 561, 6 pp.
 Sheffer Corp.

 619 Hose Ends.* Two new Hoz-Lok hote ends.
 Sheets 4430A12, 4440A12, 2 pp. Parker Fittings & Hose Div., Parker-Hannifin Corp.

 620 Air-Central Valves.* Series HH four-way, pilotoperated, air-control units. 4 pp. Hannifin Co.,
 Div., Parker-Hannifin Corp.

 621 Urethene Seels and Packings.* Characteristics
 of solid-urethane hydraulic seels and packings,
 Disagrin elastomers. 8 pp. Disagrin flustries
 Div., Pellon Corp.

 622 Smell Pumps.* Have capacities for minimum
- Disagrin elastomers. 8 pp. Disagrin industries
 Div., Pellon Corp.
 422 Smell. Pumps.* Have capacities for minimum
 metering flow to 360 gph. Bulletin 150.2, 2
 pp. Mayno Pump Div., Robbins & Myers Inc.
 423 Meters, Cempressors, Pumps.* Six sizes of air
 motors; air compressors; vacuum pumps. Catalog 660, 12 pp. Gast Mfg. Corp.

Mechanical Equipment

- 516 Drive Tensioner. 4 pp. Maurey Mfg. Corp.
- 518 Shear Pin Sprockets. 8 pp. Chain Belt Co. 520 Antifriction Bearing Screw. 22 pp. Anderson
- Co. 522 Right-Angle Transmission Template Kits. Crown
- Geor Co.

 323 Self-Lubricated Bearings. 8 pp. Bronze Bearings Inc.

 529 Sleave Bearings. 6 pp. Link-Belt Co.

 536 Reller Chain. 4 pp. Acme Chain Corp.

 624 V-Belt Drive.* Stock and nontsock drive selection; 400 sheaves for A, B, C, D-section V-belts. Catalog Section 50-C, 64 pp. Ft. Worth Steel & Machinery Co.

 625 Brenze Bearings.* Miniature Microspin units with bore ranges from 0.025 to 0.3127 in.

- Catalog 461, 18 pp. Northfield Pracision Instrument Corp.
 626 Side-Ber Chain.* Four most widely used sizes of offset side-bar chain. Bulletin 8, 4 pp. Acme Chain Corp.
 627 Chain-Drive Selection.* Rax Industrial chain, new ARSCM harsepower ratings. Bulletin 611, 12 pp. Chain-Belt Co.
 628 Magnetic-Particle Clutch.* Explanation of magnetic-particle and friction clutches, specifically covering Magnetutch. Bulletin 6005-2, 6 pp. Electric Products Div., Vickers Inc.

Assembly Components

- 508 Lock-Wesher Selection. 12 pp. Shakeproof Div.,
 Illinois Tool Works.

 117 Self-Threeding Nots. 8 pp. Palnut Co., Div.,
 United-Carr Fosterer Corp.

 524 Wire Markers. 4 pp. Westline Products Div.,
 Western Lithograph Co.

 525 Multipurpose Fastener. 8 pp. Hortwell Corp.

 531 Miniatrue Stake Nuts. 6 pp. Kaylock Div., Kaynor Mfg. Co. Inc.

 534 Nats and Belts. 8 pp. Lomson & Sessions Co.

 545 Screw-Lock Inserts. 8 pp. Heli-Coll Corp.

Manufacturing Processes, Parts

- Dis Brazins.* Dip brazing aluminum-fobrication technique. Brochure PD12, 8 pp. Precision Dipbraze Inc.
 Anticerosiae Treatment.* Formula CRC-3-36 treatment for surfaces of commonly used matculs. 8 pp. Corrosion Reaction Consultants Inc.

Materials

- 507 Designing with Titenium. 4 pp. Mechanical Research Div., Clevite Corp.
 512 Petterned Steel. 20 pp. Sharon Steel Corp.
 530 ABS Thermoglastic Resia. 8 pp. Marbon Chemical Div., Borg-Warner Corp.
 531 Steel and Plastic Twing. ** Choracteristics, size range, relative costs. Bulletin 12-10, 4 pp. Joseph T. Ryerson & Son Inc.
 632 Bearing Steels. ** Nine types for high-temperature applications. 4 pp. Aefna Ball & Roller Bearing Co., Div., Parkersburg-Aetna Corp.
 633 Prealleyed Powders. ** Properties, advantages of prealloyed stainless steel and high-alloy powders.
 Form 128, 4 pp. Heaganass Sponge Iran
 Corp.
- Corp.
 634 Prepiated Metals.* Crimp Metal Pok contains octual samples of textured, prepiated metals, plus folder of data. American Nickeloid Co., Peru, 111.
 435 Coppus Clad I.
- Peru, III.

 435 Copper-Clad Laminates.* Data on ten grades useful for printing on etched circuits. 6 pp. Synthane Corp.

 436 Synthetic Supphire.* For wear-resistent surfaces, infrared and light transmission, and insulator applications. 4 pp. Industrial Sapphire. Co.

 437 Metal Coetings.* Laqua system for protection from corrosion of plated and bare metals. 4 pp. Bee Chemical Co.

Engineering Dept. Equipment

585 Retation-Anelyzine System. 4 pp. Tectronix Inc. 539 Electromic Tunine Set. 18 pp. Hallicrafters Co. 540 Recorder-Reproducer. 4 pp. Consolidated Electro-dynamics Corp.

438 Leberstery Oscillescepe.* Type 519 high-speed unit for wide-band phenomena. Bulletin A-2023, Tektronix Inc.

Digital Recerder.* IDR-60 recorder for com-puter programming and other fields. Bulletin IDR 6150, 6 pp. Industrial Systems Div., Min-neapolis-Honeywell Regulator Co.

640 Recorder-Repreducer.* Model 102A two-channel, analog-data tape recorder-reproducer. Bulletin A3, 4 pp. Mnemotron Corp.

641 Semiconductor Test Sets.* For use in circuit design. 4 pp. Owen Laboratories Inc.

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NEW PARTS, MATERIALS, ENGINEERING EQUIPMENT

Electrical, Electronic

- 547 Dry-ceil terque meters have strokes from 0.005 to 0.015 in. American Measurement & Control
- 10.

 S56 Synchronous induction meter has pull-out torque of 8 az-in. minimum. Task Corp.

 S66 Printed-circuit connectors for microminiature electronic applications. Electronic Sales Div., DeJur-Amsco Corp.
- 865 Ministure relay secket has rear-entry, snap-in contacts. Viking Industries Inc.
- 871 Printed circuits operate in temperatures to 1300 F. Ceromics International Corp.
- 572 Small induction motors have two new mounting styles. General Electric Co.
- 875 Bimetal disk thermostat for use at tempera-tures to 350 F. Therm-0-Disc Inc.
- 577 Electrical connectors are rated at 750 v rms with 10 amp capacity. Beauchoine & Sons Inc. SB1 Pressure-vacuum cantral for operation to 500 psi. United Electric Controls Co.
- 884 Tefles-insulated terminals include four new types. Combridge Thermionic Corp.
- \$88 Slide switches are for use on instruments and small appliances. Circle F Mfg. Co.
- 890 Insulated thermestat has long, bimetal-actu-ated contact. Chatham Controls Corp.

Hydraulic, Pneumatic

- 551 Fluid-flow regulater incorporates 100-mesh screens. Lee Co.
- 853 Selemeid valve incorporates completely encap-sulated magnetic circuit. Peter Paul Electron-ics Inc.
- 858 Check valve has operated pressure of 3000 psi and up. Bruning Co.
- 843 Retary face seals for temperatures from -65 to +520 F. Hydrodyne Corp.
- Flow regulators have free-flow rates to 20 gpm. Vickers Inc., Div., Sperry Rand Corp.
 Adapter fiftiess permit making complex monifolds. Crawford Fitting Co.
- 576 Relief velves isolate any portion of hydraulic or pneumatic systems below a preset point.

Circle Seal Products Co. Inc.

- 579 Air and hydraulic cylinders have full cartridge rod bearing. Carter Controls Inc.
- 583 Spiral-Wrap base operates in working pressures to 3000 psi. Aeroquip Corp.

- 585 Selencial valve operates at pressures to 200 psi. General Magnetics Inc.
 589 Ministure valve incorporates positive bonnet lock. Robbins Aviation Inc.
 591 Pipe-thread fitting for pipe sizes from 1 to 3 in. Anchor Coupling Co. Inc.

Mechanical Equipment

- 546 Recirculating relier bearing has low coefficient of friction. Kaydon Engineering Corp.
- 548 Ministure clutches meet high performance requirements in over-running and indexing uses. Formsprag Co.
- 552 Shaft key eliminates backlash and relative ro-tational movement. Sure-Lok Co.
- 334 Bellews couplings in subminiature to medium size. Instrument Div., Sterling Precision Corp.
- 559 Sleeve beerings incorporate rotatable cartridge to provide langer life. Link-Belt Co.
- 564 teler pulleys have full-complement, double-row ball bearings. New Hampshire Industries Inc.
- 566 Shaft extensions are furnished in $\frac{1}{6}$, 3/16, or $\frac{1}{4}$ -in. shaft sizes. PIC Design Corp.
- 568 Automatic clutch for single-cylinder engines developing 31/2 to 6 hp. V-Plex Clutch Corp.
- 573 Flange bearing in shaft sizes from 1/2 to 1 7/16 in. OD. Fafnir Bearing Co.
- 578 Flexible coupling is cushioned in urethane rub-ber. Olson Industrial Products Inc.
- 580 Relier chain has 40 per cent fewer wearing surfaces. Jeffrey Mfg. Co. 586 Pillow block is available in ½ through 1-in. shaft sizes. Randall Graphite Bearings Inc.
- 587 Flexible coupling for applications with high torque requirements. Dodge Mfg. Corp.

Assembly Components

549 Fleating lock nuts for honeycomb or sandwich-

Descriptions start on Page 206.

type panels. Delron Co. Inc.

- \$57 Flush-mounted fasteners meet MIL-N-25027 re-quirements. Stake Fastener Co. \$61 Split lecking celler of self-lubricating wood. Paramount Oilless Bearing Co. Inc.

- 542 Industrial fastener has tamperproof head design. Reliance Div., Eaton Mfg. Co.
 570 Drum dials and verniers in 1½, 2, 2½, 3-ia.
 sizes. Ackerman Engravers.

Materials

- 850 Two-part epoxy edhesive resists heavy peel and shear forces. Adhesives Div., United States snear forces. Stoneware Co.
- 555 Aluminum-vinyl laminate in flat or coiled sheet has many opplications. Aluminum Co. of America.
- Silicone-rubber compound for wire and cable insulation. Silicone Products Dept., General Electric Co.
- 582 Chemical paste cleans and treats aluminum surfaces. Hughson Chemical Co., Div., Lord Mfg. Co.

Engineering Dept. Equipment

- 892 Miniature tachemeter checks both constant and changing speed. Pioneer Electric & Research Corp.
- Orp.

 Drafting table permits complete board counter-balance. Hamilton Mfg. Co.
- DC power supplies are low-voltage, solid-state units. Dynex Industries Inc. Thermal shock chambers have accuracy of 1/2 deg F. Cincinnati Sub Zero Products.
- Vertical file accommodates sheets to 36 x 48 in. Plan Hold Corp.
- 597 Reaction torque sensor measures torque by re-straining the case of the test device. Labow Associates.
- Surface-finish indicator measures surfaces from 1 to 1000 mu in. Brush instruments Div., Clevite Corp.

EDITORIAL ARTICLES

Single copies of the following articles are available as long as the supply lasts. Starred items are from previous issues. See Page 256 for other available reprints. Editorial content of Machine Design is indexed in the Applied Science Technology Index and the Engineering Index, both available in libraries, Microfilm copies are available from University Microfilms, 313 N. First St., Ann Arbor, Mich.

- The Retary Ensine. New English power plant seeks to extend the performance of internal-combustion engines. (2 pp.)
- How To Sell Ideas. Presenting ideas to management; what sales resistance to expect. pp.)
- High-Pressure Hydraulics. Design, safety, cost factors involved in designing or specifying a high-pressure hydraulic system. (7 pp.)
- Reverted Geer Trains. Determining the nur ber of teeth needed to set exact ratios a reverted gear train. (4 pp.)

- Press-Fitted Shefts. Design rules for analysis of stress conditions leading to failure; designing for a given safety factor. (2 pp.)
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- Concentric-Shell Structures. Analyzing the be-havior of strut-connected, concentric-shell structures under load. (5 pp.)
- Four-Bar Mechanisms. How to select dimensions for best force conditions by using optimum transmission angle. (4 pp.)
- rimum transmission angle. (4 pp.)

 13-10 Filament-Wound Pressure Vessels (Abstract).
 Basic characteristics of filament-wound parts;
 advantages; design equations. (3 pp.)

 12-4 Clearance in Relling Beeringss.* Calculation of
 probable bearing life for any amount of
 diametral clearance or preload. (5 pp.)

 12-5 Synchra Systems.* Advantages and limitations
 of synchro devices; use and applications.
 (6 pp.)
- Nenstanderd Crossed Helical Gears.* How to use an extension of basic helical-gear design practices to get many ratios from a single pair of blank sizes. (8 pp.)
- Least-Squares Lines.* Techniques for assessing the statistical significance of a line drawn

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- Measuring the Engineer." Newest methods of aptitude appraisal; procedure for doing the job efficiently. (6 pp.)
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TITLE

CARD INVALID WITHOUT COMPANY NAME

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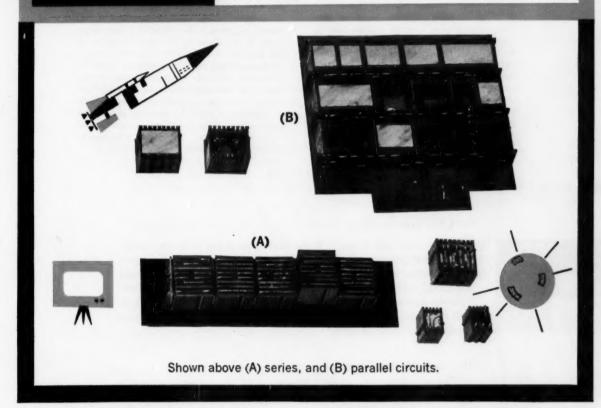
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Reader's Service Dept.

FOR 3-D CIRCUITRY IN OR OUT OF THIS WORLD

From consumer to cosmos . . . at home with wall-to-wall carpeting or out among the stars . . . wherever modern electronic functions are used . . . AMP-MECA's new 3-D circuitry concept gives you two basic and very important advantages:

- 1. EASY DESIGN: Circuit designs, based on cellular units plugged into circuit-carrying side rails, can be laid out on graph layout sheets in hours rather than days or weeks.
- 2. TESTING AND MAINTENANCE: Potted cell modules or repairable cell modules are pluggable for ease in testing or maintenance.



AMP-MECA gives the designer "building-block" latitudes . . . can be large or small as required . . . accommodates present standard or the most advanced molecular components and is equally at home in commercial as well as the most complex military equipments. Whether you're dealing with standard components, micro-miniature components, micro-modules, or thin films for use in proprietary or commercially available circuits, AMP has the solution to your interconnection problem.

For more facts . . . and information about AMP-MECA kits, write today!

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GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

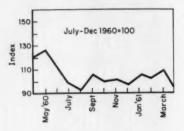
AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

trends

engineering/personal

Employment Market Bullish

The demand for engineers and scientists plunged during April, reversing an upward trend which began the first of the year. This information is from the Engineer/Scientist Demand Index compiled by Deutsch & Shea Inc., New York; figures are based on newspaper classified advertising, newspaper display advertising, and technical journal advertising. After nine months of keeping the Index, Deutsch & Shea consider it a barometer which foretells major economic changes.



A HOW-TO FOR HIRING, based on interviews with several hundred students and recruiters, tells the latter that they should probe the self-image of students.. The book, Effective College Recruiting, advocates learning the student's desires for recognition, associations, and security, as well as activity at which he feels adequate. Interviewees like to talk a lot to an interested listener. Authors are George S. Odiorne, director, Bureau of Industrial Relations, and Arthur S. Hann, placement director, School of Business Administration, University of Michigan.

TOO MANY MEETINGS, a complaint of numerous engineers, is the subject of a study being made by the Technical Planning Committee of the Engineers Joint Council. Charles F. Savage, chairman of the committee, outlined a plan to investigate and make recommendations for correcting the situation. Points to be covered include: Satisfaction derived from a meeting, fair, or exposition (judged by quality); reasons for participation in technical society work; and "society preservation," or tendency of a group to exist when there is no longer a need for it.

materials

Stick-On Tape Is a Heat Shield

Ice cubes stay cool in spite of the blowtorch aimed at them because of the tumbler's protective layer of Mystik PD-455. This is a pressure-sensitive, heat-reflective tape—a laminate of aluminum foil and glass cloth with a silicone adhesive—developed to protect missile components during blastoff. The tape, made by Mystik Adhesive Products Inc., Chicago, also has good resistance to abrasion and chemicals, excellent resistance to aging.

Made-in-USA Beryllium

For the first time, commercial quantities of beryllium will be fabricated from a domestic supply of ores, according to an announcement by the Beryllium Corp. and United Technical Industries. Beryllium oxide will be produced by a proprietary UTI process to meet requirements of the world's largest producer of beryllium alloys. Heretofore produced only from imported beryl ore, BeO will be extracted from disseminated beryllium-bearing clays found in Utah.

A VERSATILE THERMOPLASTIC RESIN—with properties related to low-density polyethylene, plasticized vinyl, and rubber—can be used alone, filled with low-cost materials, or blended with other substances to improve their properties. The resin, a copolymer, is called Poly-Eze by its developer, Spencer Chemical Co., Kansas City, Mo. One of its most unusual properties—elasticity without the need of a plasticizer—is being evaluated for tubing where slip-fit connections could save money.

HIGH PURITY AND DENSITY are combined in a translucent magnesium oxide developed by Minneapolis-Honeywell Regulator Co. Dr. Finn J. Larsen, vice president in charge of research, says the new high-temperature ceramic comes within 2 per cent of the "maximum density possible," which makes possible better finishes. When it is chemically polished, the material has a strength of 45,000 psi—almost twice that of ordinary magnesium oxide. Its melting point is 2800 C.



MOST POWERFUL electron microscope in the world has been installed at the University of Pittsburgh, for use in the Anatomy Dept. Specimens may be observed on a large fluorescent screen or photographed on plates or 35-mm film. The instrument provides direct magnification from 300 to 200,000 X and beyond 2,000,000 X with photo enlargement. Resolving power is consistently below 10 angstroms. The Norelco EM-200 microscope is made by Philips Electronic Instruments, Mount Vernon, N. Y.

SOMEONE ELSE'S RESEARCH should be used by more firms, says John C. Green, director of the Office of Technical Services, U. S. Dept. of Commerce. Writing for Datex Digest, published by Datex Corp., Monrovia, Calif., Mr. Green points out two mines of information not being used effectively: 1. Research by large companies, available at reasonable cost through license agreements. 2. The Federal Government—world's largest sponsor of research—which produces 1000 reports each month.

aero/space

NASA Simplifies Saturn

Design changes in Saturn—which will launch the Apollo spacecraft—have been announced by NASA. Instead of three stages, a two-stage Saturn C-1 will be used for the first ten research and development flights. On the last four flights, early models of the Apollo may be placed in earth orbit. Payload capability will be about 20,000 lb in low earth orbit, made possible by two extra engines which increase thrust of the second stage from 70,000 to 90,000 lb, and a planned increase in propellant capacity of the booster.

Tiros II on Borrowed Time

On May 23, the meteorological satellite Tiros II chalked up six months' time in orbit; its estimated life was about three months. The satellite's purpose was to provide global weather observations via two television cameras and two experimental infrared sensing systems. In six months it transmitted 31,485 photographs, over 75 per cent of which were "fair to good" for meteorological analysis. Of the seven sensors, only one still operates, but during its four or five months of useful operation, the IR equipment provided a great mass of data.

products/processes

Westinghouse Tackles the Pacific

The largest multistage flash-evaporator plant in the U. S., being built by Westinghouse Electric Corp. at Point Loma, Calif., will provide 1,000,000 gal of desalted water a day. In the process, heated sea water is sprayed under pressure into a series of cooler, lower-pressure chambers; in each one, some water "flashes" into almost-pure vapor, is condensed and piped off. The plant is to be completed in November.

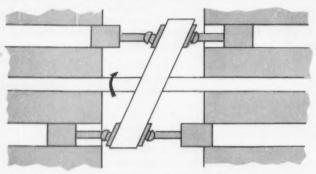


TUBING IS REDRAWN with walls only 0.0005 in. thick—within tolerances as close as ± 0.00005 in.—by Uniform Tubes Inc., Collegeville, Pa. It is available in sizes from 0.010 to 0.375 in. OD, in 300 series stainless steel. The company calls attention to this tubing's extremely light weight: Ten miles of the largest-diameter size weigh less than one pound.

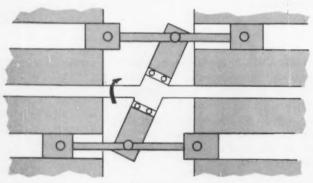
HARDENING AND TOUGHENING any highspeed steel up to two full points higher on the Rockwell C scale is accomplished with the new Sunite process developed by Sun Steel Treating. Inc., Farmington, Mich. Hardening is uniform from surface to center. The technique, developed for precision hardening of tools, is also suitable for mass-produced components.

Another Go-Around for the

Milestones in Rotary-Engine Development . . .



Michel Engine: Swash plate fixed at an angle to a rotating shaft imparts reciprocating motion to the pistons. Chief disadvantages: High end thrusts on the shafts, plus lubrication problems at sliding contact of swash plate and slipper bearings.



Redrup Engine: Rotation of the main shaft (disc, mounted on bearings, does not rotate) produces a motion similar to the swash plate. Slipper bearings are not used; two universal joints transmit motion via the connecting rods to the pistons. Rapid reversal of stress as the joints describe tight lemniscates causes frequent connecting-rod failure.



Wankel Engine: Rotary piston, roughly in the shape of a triangle, rotates eccentrically so that its vertices describe a two-lobe epitrochoid (the combustion chamber). Obvious sealing problems pose the main obstacle in development of the engine.

English-designed powerplant joins the ranks of unconventional, but plausible, prime movers

TO DIEHARDS in rotary-engine development, the straight-line internal-combustion powerplant is nearing the end of its development:

"There has been no substantial improvement in the gasoline engine during the last 30 years. The diesel, while replacing the conventional otto cycle in practically all applications except pleasure cars, is also near the end of its development.

"The reason for this unhappy passe is that reciprocating stresses set up in the conventional piston-connecting rod-crankshaft system limit the top speed to about 7000 rpm. This, of course, sets an upper limit on the power available from a given engine.

"One answer to the problem is an engine that would run on gasoline and which would have a purely rotary motion (the gas turbine is too fast and has a relatively low thermodynamic efficiency). The ideal would combine high thermodynamic efficiency with low mechanical stresses."

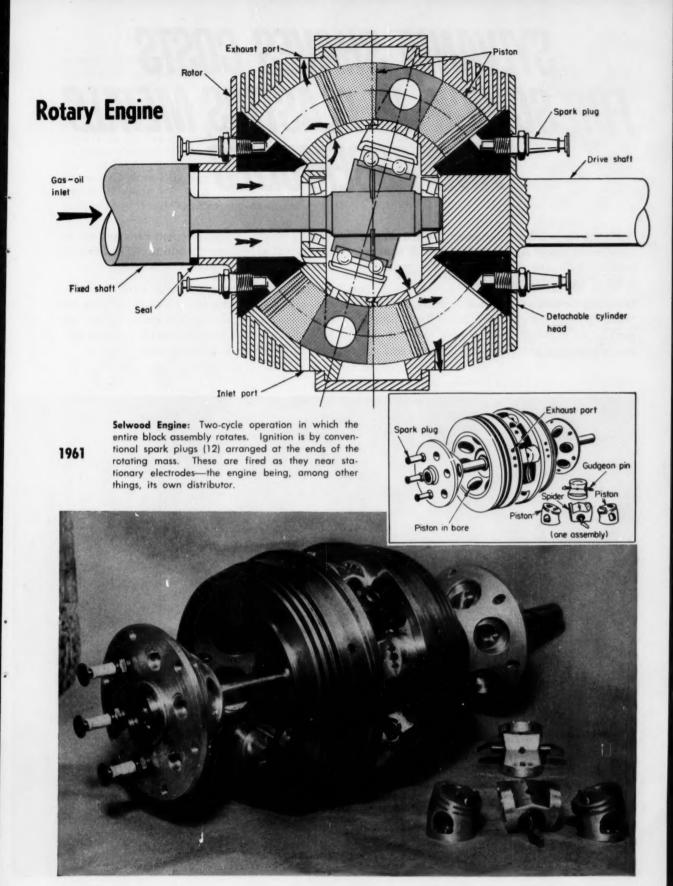
The latest rotary to appear is an English product, known as the Selwood (for William R. Selwood Ltd., Engineers & Machinery Merchants, Chandler's Ford, Southampton, Hants, England).

In the Selwood engine, there are six cylinders spaced equally round a cylinder block and 12 pistons (two per cylinder) arranged on each side of a spider which performs the same function as a swash plate. The entire block assembly rotates.

As is usual in a two-stroke engine, exhaust gases have to be scavenged from the cylinders, but the conventional method of using the underside of the piston to supply the pressure for scavenging cannot be used because the engine is double-acting. A rotary compressor mounted directly on the output side will probably be used.

1939

1960



June 22, 1961

SYLVANIA SHAVES COSTS FOR SCHICK-IN PLASTICS, METALS AND ASSEMBLIES

Producing the switch for a compact, 3-speed electric razor leaves almost no margin for error. It must be precisely built and still withstand the punishing abuse of day-to-day handling.

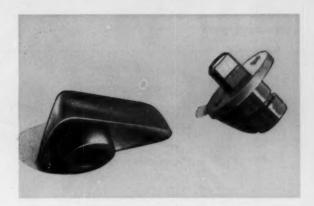
In making the switch for the new Schick razor shown below, Sylvania Parts Division meets these requirements. Our experience with a wide range of materials resulted in better electrical contacts. And our facilities assure durable, precision parts and assemblies as well as high-speed production. The combination means important economies to Schick.

For details, see captions at the right. For full information on how Sylvania custom parts facilities can benefit *you*, or for a quote on a specific project you have in mind, write Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania.



MOLDED FROM PLASTIC are parts for the switch assembly. Each must meet the tightest specifications. Example: Sylvania molds shaft and selector button from nylon, holds dimensions on both to a height and diameter of ±.0015". In addition, the flash is controlled to 1/32" because the button is a snap fit on the shaft. Since Sylvania maintains one of the world's most modern and complete lines of automatic molding equipment, it can handle volume orders for compression, injection and transfer molding. And a unique bank of rotary presses can produce millions of precision parts each day—even using phenolics and urea.

Result to Schick? Precisely molded parts-in volume!





CUSTOM METAL STAMPINGS also proved important to Schick. Sylvania recommended changing the selector detent and rotor to brass, thus permitting a reduction in thickness from .015' to .010' and assuring an improvement in contact from rotor arm to detent. Sylvania made the dies necessary to produce these parts. The Sylvania metal stamping facility includes multi-slide machines, vertical presses and specially developed machines to help solve your problems.

Result to Schick? Positive electrical contacts assured while a 5° offset on the selector rotor is maintained to within ± 1 ° day in and day out.

CUSTOM ASSEMBLY by Sylvania of the switch assembly is handled by our corps of trained specialists. Many of our customers have found that Sylvania can often deliver completely assembled and packaged products—using either all Sylvania components or a combination of some Sylvania and some customer supplied—at lower cost than is possible in the customer's own facilities.

Result to Schick? Thousands of completed, durable and precision assemblies per month.



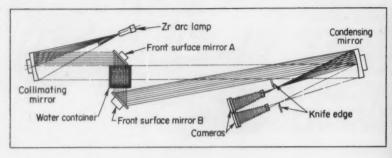
NEED CUSTOM WELDING OR WIRE? Sylvania supplies both. To help you meet your welding needs, Sylvania has developed new high-speed, high-volume techniques and advanced welding equipment—automatic and semiautomatic. To help you with wire, only Sylvania of all major manufacturers makes all three types of bare wire—alloy, clad and plated. They're available in a full range of sizes, too—.002" to .250". Where necessary, Sylvania will precision-roll wire into ribbon connectors that offer high reliability when the circuitry calls for wire wrap contact methods.

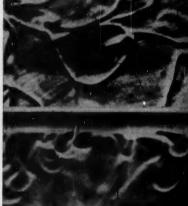
SYLVANIA

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GENERAL TELEPHONE & ELECTRONICS







Convection-Current Tricks Caught in Schlieren Photographs

DISCOVERY of unusual convection disturbances in a quiet body of water has led National Bureau of Standards researchers to speculate that similar phenomena may occur in any lake, pond, or body of water exposed to still air. The findings help explain some of the phenomena observed in such fields as oceanography, meteorology, astrophysics, and hydraulic engineering. Instead of the cellular mode of convection usually reported, the convection took the form of plunging vertical sheets and columns. Schlieren photographs were used to record the movement without inserting disturbing elements into the water. Setup used (above) gave simultaneous top and side records.

Plate-glass tank is used by NBS for convection experiments. Mirrors over and under the tank created a light path for vertical observation of disturbances. Top and side view of convective sheets in water (above right) show precipitous plunging of water chilled by surface evaporation. When circulation reaches steady state, plunging is only occasionally visible.



More on Value Engineering: The Cold-War Pinch is On

Moorestown, N. J.—Importance of value engineering lies in a fundamental change in availability of resources among the major powers, says Carlos Fallon, administrator of value engineering for RCA's Missile and Surface Radar Division. In a recent address to the Institute of Radio Engineers he pointed out, "Militarily, the Western World must provide better weapons per pound weight, better weapons per cu ft of space, better weapons per man/month of design . . ."

In answer to the question: "Where was this branch of operations research when our priceless resources were being poured down the drain in World War II?" Fallon answers, "It was there all right, helping pour, but not down the drain . . . Our most priceless resource then was time . . . to develop radar, sonar,

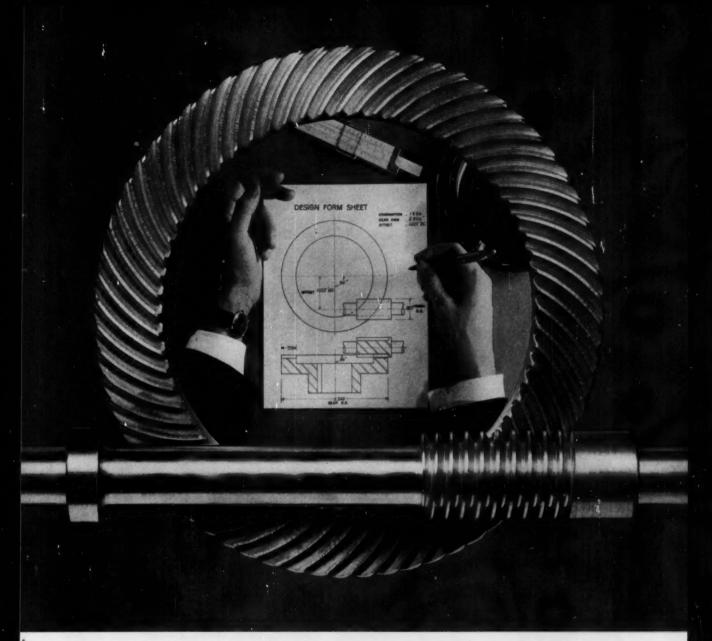
to coil for the attack. We traded industrial production for time, sending five bombers for every fighter the enemy put in the air, five ships for every torpedo he put in the water."

Now the mix is different, Fallon thinks. Our advantages to be exploited are:

- A diversified scientific community with a cultural background of great depth and breadth.
- A broad-front technology uniformly advanced in most phases of endeavor.
- Freedom from doctrinal constraints.
- A mechanism for unemotional self appraisal at the national and international level.

Value engineering weighs, compares, and balances desirable characteristics of a program to achieve an optimum balance at minimum cost in available resources.

Coupled with the old-time instinctive approach, which every design engineer uses consciously or unconsciously, is a more formal mathematical approach in which the basic formula is: Value = Function + Cost. Although this appears to be a simple formula, says Fallon, it becomes very complex when one tries to express mathematically the relationship between such components of function as capability, performance, reliability, and ruggedness vs. ease of service, operation, and maintenance; or, to arrive at cost, it is difficult to balance such factors as development time, weight, volume, power requirements, and dollar cost. Obviously it takes a lot of skill to put these components together in the right order and with the right weighting for any particular job.



Why it will pay to design your high reduction gearing with Gleason HRH*

If you want to make your transmission more quiet or more compact or more flexible, take a good long look at the HRH set shown above.

This single set of gears gives a reduction of 66 to 1.

The action is quiet and smooth and continuous because the pinion teeth wrap around the gear teeth. With this design you can work such quiet operation into your designs even with a one- or two-tooth pinion member.

You can add the rigid support of a straddle mounting, since bearings can be put on both ends of the pinion.

HRH gear ratios are made with proven face mill cutting techniques, assuring complete control of tooth contact pattern to compensate for any assembly or operating condition.

HRH gear ratios are designed with the full assistance of all

Gleason engineering services. We work with you on the practical design aspects and carry through to the development of prototypes. Then we furnish both machines and tooling for full production—without royalties.

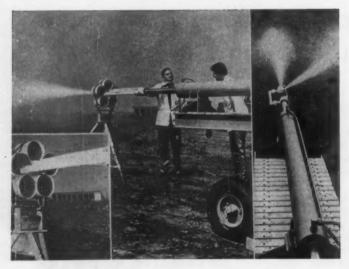
Find out what HRH gearing can do for your transmissions. Send for our design form sheet and then send us the gear ratios and sizes you want. We'll send back detailed recommendations promptly.

*Trademark for Gleason High Reduction Hypoids





ENGINEERING NEWS
PICTURE REPORT



Two new light aircraft, the Airedale (top) and the Terrier, are introduced by British Executive & General Aviation Ltd. The Beagle-Auster Airedale has a wheel instead of a stick for control, tricycle undercarriage with steerable nosewheel, and "an advanced type" of starting panel in the cabin roof. It is a four-seater with automobile-styled interior and front and rear doors as well as a separate baggage door. Powered by a 180-hp Lycoming 0-360 engine, it cruises at over 140 mph. Range is 1050 miles. The Terrier, developed from a military trainer, is described as a three-seat trainer-tourer. Noise level has been reduced both externally and internally by a long exhaust pipe with a silencer. The plane has a 145-hp De Havilland Gipsy Major 10 engine. Cruising speed is 110 mph; range, 415 miles.

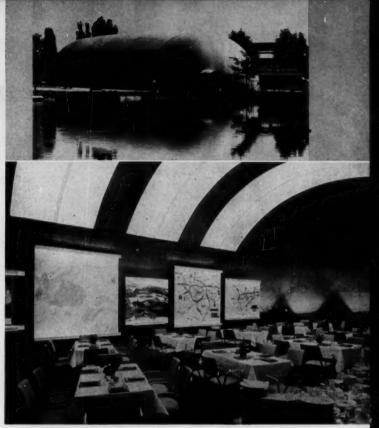


All-transistor, pocket-size citizens band transceivers, made by the Raytheon Co., weigh less than 15 oz, measure 5½ by 2¾ by 1 3/16 in. The Ray-ette is a superregenerative unit, usable where high electrical noise levels interfere with most other communications equipment; the Ray-ette Super has superheterodyne circuitry. Rated at 100 milliwatts, the transceivers can be used at distances up to 2 miles over land and up to 5 miles over water.

High-velocity liquid, delivered in a tiny stream under thousands of pounds of pressure, cuts through cement, wood, and plastic. Designed for cutting solid propellant materials, the "liquid lathe" was developed and built by Abrasi-Jet Machine Tool Corp., Glendale, Calif.; the liquid cutting concept came from the Los Angeles Div. of North American Aviation Inc. In a recent demonstration, simulated solid propellant (a tough plastic) was sliced through, as shown in the inset at left.



An atomic "clock" that loses only I second in 300 years, the Rubidium Frequency Standard provides a frequency source stable to one part in 10¹¹ over a period of one month. Such a device, designed for exacting frequency and time measurements in the laboratory, may be used in communications and navigation systems of aircraft and space vehicles. In the clock, a beam of light is passed through a rubidium gas cell to provide a difference in the energy state of the atoms of rubidium. Subsequent transitions from one of these energy states provides the microwave reference on which the device depends for its stability and its function as a time-measuring instrument.



Blowing up a building in Germany, 1961 style, creates a storage area, exhibition or banquet hall, theater, or sports arena. A rubber-lined or plastic air house such as this 15,000 sq ft one designed by Fried. Krupp, Essen, is inflated at slightly above atmospheric pressure and kept in place by pegs in the ground. To prevent escape of air, revolving doors function as airlocks for people and vehicles.



A bigger Echo than the first communications satellite, Echo II is 135 ft in diameter and weighs 500 lb; it has 82 per cent more reflecting surface than the 100-ft diameter, 136 lb Echo I. When placed in orbit next year, the new space reflector will provide a superior target in NASA's program to evaluate the effectiveness of passive satellites for bouncing radar and radio signals off aluminum-surfaced balloons. Echo skin is Mylar, laminated on both sides with ultra-thin aluminum foil produced by Alcoa.



Freezing of bearing lubricant in a liquid-oxygen missile is prevented by a special heater built by General Electric Co. for Aerojet-General Corp. The bearing is part of the Lox pump drive in the Titan missile. Its two heaters use small-diameter hypodermic-needle tubing for sheaths, and resistance wire is encased in rock-like insulation. Fitting into machined grooves on the bearing sleeve, they have an output of 40 w per sq in. of heater surface.

Systems for Nuclear Auxiliary Power

NAP

The key to exploration in deep space is electric power. Everything from vehicle lighting to propulsion will depend on electricity. The dramatically successful Snap program provides a selection of power sources to meet any foreseeable demand.

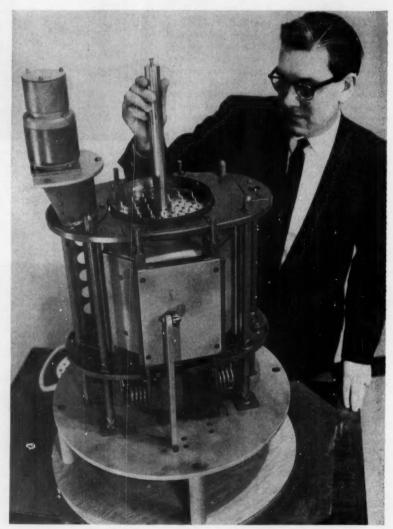
AT the present time, the United States has several thousand pounds of satellites traveling in orbit about the earth. The total electrical power aboard these vehicles is less than 100 watts. To date, only batteries and solar cells have been used, and cost of producing power has averaged \$1000 per watt.

Explorer VI, launched in 1959, contained a typical solar-power unit. The device accounted for 35 lb of the total weight of the 142-lb satellite. If operated at its full rated power of 25 watts (which it failed to do), the solar source would have produced 0.7 watt per lb.

Snap systems, now in various stages of advanced development, will provide anywhere from a few watts of power up to 60 kw. Radioisotopic systems (SNAP 3) will cover the power demands ranging to 100 watts. Above that, reactors (SNAP 2, 8, and 10A) will be used. Weight of kilowatt-size SNAP systems will be 50 lb per kw; cost of power is estimated at \$300 per watt.

One of the earliest and best examples of compact reactors for space is SNAP-2. The first "2" reactor was designed as a proof-of-principle unit. The unit has completed a year's testing during which it generated 225,000 kilowatt-hours. This is equivalent to ½ year of operation at design conditions. It has also operated continuously for a 1000-hour run at design conditions of 1200 F, at a power level of 50 kw of thermal power. The reactor core, tank reflector, and other hardware weighed just 250 lb.

Results of this experiment led to changes in fuel composition, num-



All reactors in the Snap program will be based on this working prototype of Snap 2. Its small size is due to a unique fuel alloy which combines both the fissionable material and the moderator in one substance. Control of nuclear reaction is accomplished by simple mechanical motion of the beryllium neutron reflectors surrounding the core (roller-linkage in picture). Reflectors must be in closed position, as shown, before reactor can operate.

HIGH-SPEED OPERATION

Balanced release levers permit high-speed drives. Lever "throwout" is eliminated for longer bearing life. Patented anti-friction rollers give instant release with minimum pedal pressure.

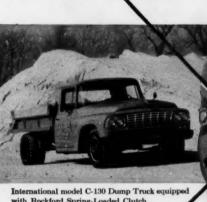
2 ACCURATE FIT

Close-tolerance drive between cover and pressure plate assures smooth starts. Highly accurate bolt circle fits flat flywheels—accurate out-side pilot diameter fits counterbored flywheels.

S VIBRATION DAMPENER

Coil-spring vibration dampener absorbs vibra-tions between engine and transmission. Noise, rattle and thrash in the gear train are eliminated for smooth, quiet clutch operation.

ROCKFORD SPRING-LOADED CHITCH



with Rockford Spring-Loaded Clutch

4 HIGH-TORQUE DESIGN

Powerful engagement springs, properly spaced over the facing area, assure maximum driving contact. Compact, lowinertia design prevents gear clashing and de-layed shifting.

5 SMOOTH ENGAGEMENTS

Dynamic and static balancing assures you of smooth, enduring clutch performance. Both driv-ing and driven members are balanced to eliminate vibration.

6 HIGH-TEST FACINGS

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7 PERFECT ALIGNMENT

Close-tolerance splined hub assures perfect disc alignment. Throughhardened hub gives long life. Precision manufacturing and rigid quality control eliminate chances for misalignment.

RELEASED

ENGAGED

7 Good Reasons Why Idea-Men Count on Rockford Reliability

Above are seven reasons why more and more design men specify Rockford Spring-Loaded Clutches. Equally important, ROCKFORD RELIABIL-ITY is due to 63 years of creative engineering, precision manufacturing and rigid quality control. Rockford offers complete design engineering service at no cost or obligation. You're backed by a worldwide service network. Write today for complete details on ROCKFORD RELIABILITY.

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BORG. WARNER ber and size of fuel rods, and reflector design, permitting a reduction of weight in the second SNAP power reactor known as S2DR.

S2DR weighs 200 lb without shielding. Its core, which is 13 in. high and 9 in. in diameter, generates 50 kw of heat. The S2DR will power the first complete package system using flight-capable conversion hardware. This system, capable of generating 2000 watts of electrical power, will be delivered to the Air Force in 1964.

SNAP-8 is a larger version of SNAP-2 and will produce 30 kw with one power-conversion unit (mercury vapor turbine-alternator) and 60 kw with two power-conversion units coupled to the same reactor. NASA has announced that SNAP-8, if developed successfully, will be used for many purposes requiring large amounts of electricity, such as electric propulsion engines for travel in deep space.

The first SNAP-8 Experimental Reactor will go critical early next year; flight tests will be conducted in 1965.

SNAP-10A will demonstrate the capability of the SNAP reactor powering a thermoelectric converter which will be located in the vehicle skin. The reactor is essentially the same as in SNAP-2, but the converter in this system will generate 500 watts. Flight testing of SNAP-10A is scheduled for 1963.

Molybdenum containment block sealed with tapered steel plug

Lead telluride n-type element doped with sodium

Lead telluride n-type element doped with bismuth

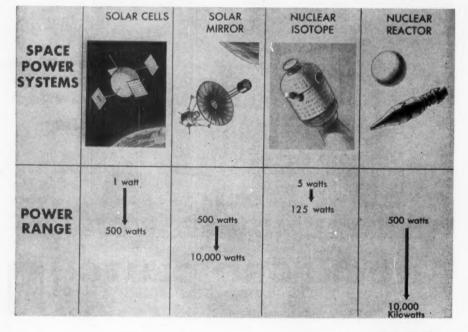
Hot junction (490 C)

Element adjustment screw

Copper containment shell evacuated to 1mm of mercury (Surface temperature 99 C)

Ready now, Snap 3 represents a family of thermoelectric devices which use radioisotopes as heat sources. The first "3" was fueled with polonium 210, produced $3\frac{1}{2}$ watts, and weighed 4 lb. The latest model, fueled with plutonium 238, uses thermionic conversion to produce 6 watts. It weighs less than 1 lb. Scheduled launching of Snap 3 in Navy's Transit navigational satellite is causing diplomatic concern at the moment. But spokesmen for the Martin Co., Snap's designer, say the chance of a radioactive accident is nil. Metal containers in which the isotopes are sealed have been plunged red hot into liquid oxygen, fired against concrete walls, and exposed to the fireball of an explosion simulating a major rocket failure. No isotopes have escaped.

Power for space is available from four basic types of systems. Only one — the solar cell-battery system—has been used to date.

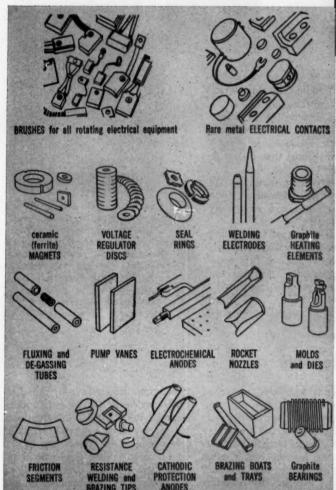


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Carbon, its crystalline kin, graphite, and various metal powders are the raw materials of Stackpole Research—a specialized branch of powder blending and molding aimed at developing new uses and improved manufacturing techniques for "Everything in Carbon but Diamonds."

Here, one of many new instruments in the expanded Stackpole Research Laboratories—a nitrogen absorption analyzer—measures powder surface areas as part of a program to develop economical new techniques for milling carbon powders.





CLEVELAND—Previously available only on special equipment, adjustable-speed drives with solid-state exciters are now off-the-shelf items. A complete line of the static regulators has been designed, by Reliance Electric and Engineering Co., around diodes and silicon controlled rectifiers. The new line—first on the market—allows precise motor control, 0.1 per cent regulation at base speed, and response time that is said to be half that of the best tube-type regulators.

The static devices can be applied to dc motors ranging from 1 to 350 hp. In all sizes, the new units can provide voltage gains of 25,000:1 or better, input impedances of more than 2 megohms, and electrically

isolated (magnetically coupled) inputs and outputs.

Heart of the system is a new five-module "Cardpak" consisting of a limit (to override the input in case of sudden signal-voltage change), preamplifier, amplifier, power supply, and drive unit. Over fifty combinations can be tailored from the five basic modules. Integral test equipment permits the operator to check out each module individually, and five-unit panels can be interchanged without having to "tune" them to match the load. Panels are available with 0.5, 1.0, and 2 kw outputs.

Modular control circuits allow the drive to be torn down and rebuilt for a different job. Over 50 different combinations can be designed from the five basic modules. Integral test equipment, offered as a control-panel option, allows the operator to check-out the modules and trouble shoot in minimum time.

Air Cars-No Competition for the Auto

DETROIT — Ground-effect vehicles hold promise for special jobs, but they pose no threat to automobiles or other wheeled mass-transportation vehicles. According to Charles A. Amann and Jerold W. Scheel, engineers at General Motors Research Laboratories, air-cushion machines in mass transportation would require some new type of guidance system, probably in the form of a special roadway.

Air cars are too tricky to handle in traffic because they lack both ground friction and tire-to-road contact of standard vehicles. A gust of wind that wouldn't faze an autobile becomes a serious challenge to the driving skill of the air-car operator. A piece of land that appears level to the human eye is often proved otherwise by the downhill drift of the vehicle. Its operation is even affected by the road crown.

Another result of the absence of ground friction is lack of precise control. "While automobiles routinely pass within a few feet of one another traveling in opposite directions at relative speeds in excess of 100 mph,

this same maneuver in a ground-effect device would be a hazardous stunt," say the two GM engineers.

"It would be a mistake, however, to overlook the possibilities of the air-cushion vehicle in specialized applications . . . use over water is an example. In this application, the tasks of climbing hills and maintaining precise control . . . are usually not primary problems . . . Amphibious operation, combining in a single vehicle transportation capabilities over both land and water, offers another promising area."



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 key surfaces give Mac-it fasteners
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Meetings and Shows

June 28-30-

Second Joint Automatic Control Conference to be held at the University of Colorado, Boulder, Colo. Sponsors are Instrument Society of America, American Institute of Electrical Engineers, American Society of Mechanical Engineers, Institute of Radio Engineers, and American Institute of Chemical Engineers. Further information is available from ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

July 4-7-

National Society of Professional Engineers. Annual Meeting to be held at the Olympic Hotel, Seattle, Wash. Additional information can be obtained from NSPE, 2029 K St. N.W., Washington 6, D. C.

Aug. 14-17-

Society of Automotive Engineers Inc. National West Coast Meeting to be held at the Sheraton Hotel, Portland, Oreg. Additional information can be obtained from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Aug. 22-25-

Western Electronic Show and Convention to be held at the Cow Palace, San Francisco. Additional information can be obtained from Wescon headquarters, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

Aug. 28-Sept. 1-

International Heat Transfer Conference to be held at the University of Colorado, Boulder, Colo. Sponsors are American Society of Mechanical Engineers and American Institute of Chemical Engineers: also participating are American Society of Refrigerating and Air Conditioning Engineers, Chemical Institute of Canada, Engineering Institute of Canada, Institute of the Aerospace Sciences, Society of Automotive Engineers Inc., and the University of Colorado. Papers will be presented by engineers from 13 countries. Additional information can be obtained from ASME Meetings Dept., 29 W. 39th St., New York 18, N. Y.

Sept. 5-8-

Association for Computing Machinery. 16th National Conference and First International Data Processing Exhibit to be held at the Statler-Hilton Hotel, Los Angeles. Further information is available from Benjamin F. Handy Jr., Litton Systems, 5500 Canoga Ave., Woodland Hills, Calif.

Sept. 11-14-

Society of Automotive Engineers Inc. National Farm, Construction, and Industrial Machinery; Powerplant; and Transportation Meetings, including production forum and engineering display, to be held at the Milwaukee Auditorium, Milwaukee. Further information can be obtained from SAE, 485 Lexington Ave., New York 17, N. Y.

Short Courses and Symposia

July 10-14; July 17-21-

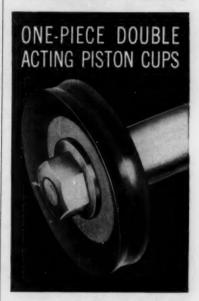
Two Programs on Strain Gage Techniques will cover both theoretical and practical considerations. The first program will consist of lectures supplemented by illustrative demonstrations. Topics include basic theory of foil and wire-resistance strain gages, details of gage characteristics, mechanical and electrical aspects of the gage system, dynamic and static strain measurements, and high-temperature strain gages and their installation. The second program will provide experience in handling strain gages and allied equipment. Exercises will include installation, dynamic strain measurements at high and low frequency, and direct measurement of force, torque, bending, and shear. Further information is available from Director of the Summer Session, M.I.T., Cambridge 39, Mass.

July 17-21-

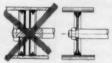
Generalized Electrical Machine Theory Course to be held at Case Institute of Technology. Lectures will include review of Laplace transform methods, theory of linear incremental models and the concept of linear transfer functions, development of the primitive generalized machine, algebra of block diagrams,

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Circle 220 on Page 19



and closed-loop linear system response. Further information can be obtained from Prof. Jerome Meisel, Case Institute of Technology, University Circle, Cleveland 6, Ohio.

July 17-28-

Short Course on Harmonic Analysis for Engineers and Scientists to be held at the University of California. Further information is available from Sam Houston, Engineering Extension, Room 6266 Engineering Bldg. II, University of California, Los Angeles 24, Calif.

July 24-28-

Advanced Topics on Solid-State Masers summer conference, to be held at the University of Michigan, will cover recent developments in the field. Topics include cross relaxation, optical pumping in solids, optical and infrared masers, advanced technology of cavity and traveling wave masers, and applications of maser systems. Further information is available from Engineering Summer Conferences, 126 West Engineering Bldg., University of Michigan, Ann Arbor, Mich.

July 24-28-

Course on Applications of Stress Analysis to Design and Metallurgy, to be presented at the University of Michigan, will cover principles and methods for applying stress analysis to problems of engineering design, material specification, laboratory testing, and field failures. Topics will include static, fatigue, and impact loading; notch sensitivity and stress concentration; size effect; cumulative damage, understressing and overstressing; problems of life expectancy; statistical interpretation of stress and fatigue data. Additional information can be obtained from Engineering Summer Conferences, 126 West Engineering Bldg., University of Michigan, Ann Arbor, Mich.

July 31-Aug. 11—

Summer Institute for Technical Writers and Publishers, sponsored by Tufts University, will emphasize editorial, supervisory, and managerial problems and procedures of governmental and industrial publications departments. Additional infor-

mation can be obtained from Mrs. Florence N. Trefethen, Assistant Director, 8 North Hall, Tufts University, Medford 55, Mass.

Aug. 13-18-

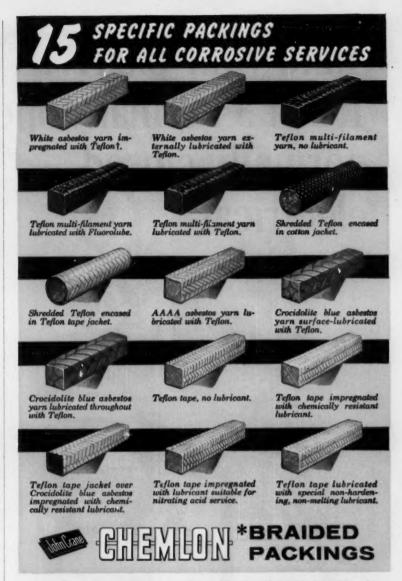
Seminar on Theoretical Aspects of Magnetohydrodynamics to be held at Pennsylvania State University. Purposes are to present basic principles of plasma dynamics; to introduce the basic macroscopic equations of magnetohydrodynamics; to study phenomena associated with wave motion, boundary layer flow, and plasma instabilities; and to present the fundamentals of plasma propulsion and power generation. Further information is available from the Conference Center, Pennsylvania State University, Universitv Park, Pa.

Aug. 23-25-

Fourth Biennial Gas Dynamics Symposium to be held at Northwestern University. Sponsors are the Electric Propulsion Committee and the Magnetohydrodynamics Committee of the American Rocket Society and the Gas Dynamics Laboratory of Northwestern. The program will cover transport properties of plasmas, magnetohydrodynamic phenomena, experimental techniques and observations, propulsion, power generation, and thermodynamic properties of plasmas. Additional data can be obtained from Gas Dynamics Symposium, Mechanical Engineering Dept., Northwestern University, Evanston, Ill.

Aug. 27-Sept. 1-

Short Course on Materials Under Thermal Stress to be held at Pennsylvania State University. Object of the course is to present intensive treatment of the present state of the art of thermal stress analysis and interpretation. Lecture topics will include elastic analysis, fundamental behavior of materials under mechanical and thermal strain cycling, inelastic analysis, thermal shock of brittle and ductile materials, and choice of materials and mechanical configuration for optimum design. Further information can be obtained from the Conference Center, Pennsylvania State University, University Park, Pa.



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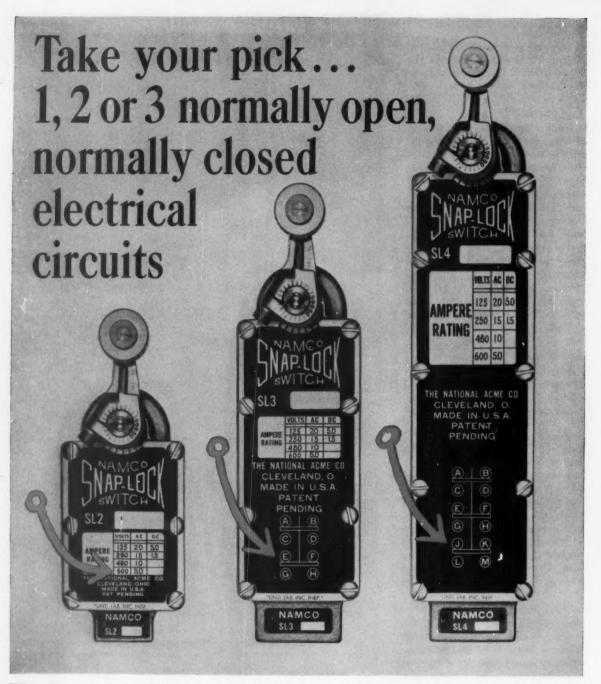
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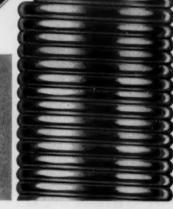
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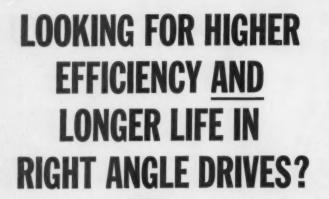
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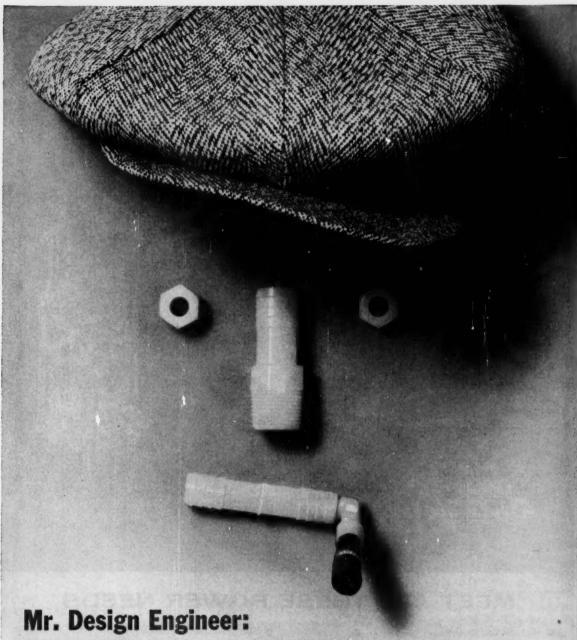
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Plaskon® Nylon is always ready when there's a tough job to be done! Rough handling and abuse in both installation and use prove the high impact and tensile strength of pipe fittings molded from Plaskon Nylon. Their corrosion resistance is superior to that of most metals; cost is often much lower.

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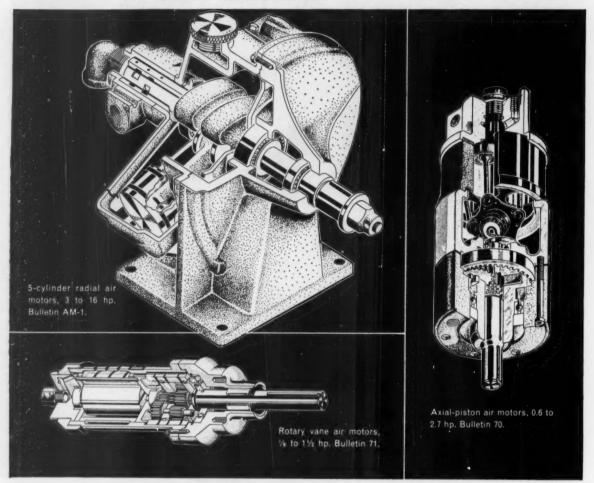
Plaskon Nylon injection molding compounds also offer less shrinkage and better dimensional control for precision parts such as gears and bearings. Parts mold easily because Plaskon Nylon doesn't "drool" and has a broader melting range. Call or write for full performance data, and for expert help with any molding problem.

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- Variable speed, easily controlled
- Cool operation
- Instantaneous starts and stops
- Consistent torque output

- Spark-resistant characteristics
- Thrust or axial spindle loads
- Enclosed construction
- Output from 1/2 to 16 hp

Your Gardner-Denver specialist will be glad to consult with you in putting air power to work in your new designs.



EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois—Offices in principal U. S., Canadian and Mexican cities. In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario. International: Gardner-Denver International Division, 233 Broadway, New York 7, N. Y. International Offices: Buenos Aires, Areanina: Artarmon, N. S. W. Australia; Brussels, Belgium; Rio de Janeiro, Brazil; Santiago, Chila; Barranquilla, Colombia; Lima, Peru; Ndola, N. Rhodesia; Salisbury, S. Rhodesia; Johannesburg, Transvaol.

REASONS FOR SPECIFYING U.E. INDICATING **TEMPERATURE** CONTROLS

- * HIGH SENSITIVITY...on-off differentials from ± .5° F with excellent repeatability
- *LOW COST . . . list prices from \$35.00 with generous quantity discounts
- * EASY MAINTENANCE . . . thermal assemblies quickly replaced in the field with no loss of calibration accuracy
- * PROVEN DEPENDABILITY... reliable liquid-filled measuring systemscombined with simple service-proven components for accurate performance and long life
- * GREATER VERSATILITY... many styles, ranges, sensing elements and switch characteristics permit hundreds of "custom-built" combinations

ALL PURPOSE

-150° to +650° F

A sensitive wide range unit with control point accuracy equivalent to individually calibrated instruments. 10" rotating scale permits unusual readability and close settings. Available with dual switches for controlling two independent circuits.





LOW COST... (800 Series) -150° to +650° F Short dial spans of 50 to 200° F permit compact design only slightly higher in price than non-indicating controls. Available with dual switches.

HIGH TEMPERATURE . . . (900 Series) 0° to +1000°F

A NEW high temperature series with rugged stainless steel mercury filled thermal systems.

For the USUAL or UNUSUAL application, United Electric offers quality controls at economical prices.



SPACE SAVING ... -150° to +650° F Skeleton design permits direct incorporation into equipment - saving cost of enclosure. Many models with dial spans of 50 to 200°F. Available with face plate for panel mounting.



SPECIAL PURPOSE ... -150° to +1000°F Shown here is a typical Special Purpose control used on medical equipment, such as baby incubators, etc. WHAT IS YOUR REQUIREMENT? Chances are one of our standard controls will satisfy your needs. If not, we'll put our 30 years' experience to work for you on special designs.

STATE



UNITED ELECTRIC CONTROLS CO.

85 School Street

Watertown 72, Massachusetts

United Electrical Controls (Canada) Ltd. United Sensor & Control Corp.

O'Connell Avenue Dorval, Quebec Box 149 Glastonbury, Com.

Write TODAY for complete U. E. Indicating Temperature	e specifications and price information on e Controls, Attention Dept. W.
NAME	TITLE
COMPANY	
ADDRESS	



From microfilm to an 18"x 24" print ... in seconds and on ordinary paper!

You can have a dry, positive, 18"x24" engineering print in seconds and on ordinary paper with the new 1824 Printer.

This remarkable machine, which requires no exposure settings or other adjustments, reproduces from a microfilm aperture card, making 18"x24" prints—or smaller—at extremely low cost. It also copies onto vellum or offset paper masters.

Operation is automatic. Prints ready for immediate use emerge as fast as four a minute.

The quality of reproduction is superb. Images are sharp black-on-white and won't rub off. There is no odor, no waste, and the finished print may be written on with pen or pencil.

Regardless of your engineeringdrawing-reproduction needs, you can now enjoy the tremendous savings in time, money, space, and materials of your own unitized microfilm system.

Formerly, such economies required a substantial reproduction need. To-day, however, the 1824 Printer offers the same proportionate benefits to small-volume users as to large. No need now for vast files of engineering drawings. Microfilm aperture cards require only a fraction of the storage space rquired for other reproducibles. No more costly waiting for prints,

which—made by an 1824 Printer are so inexpensive your engineers can discard them after use.

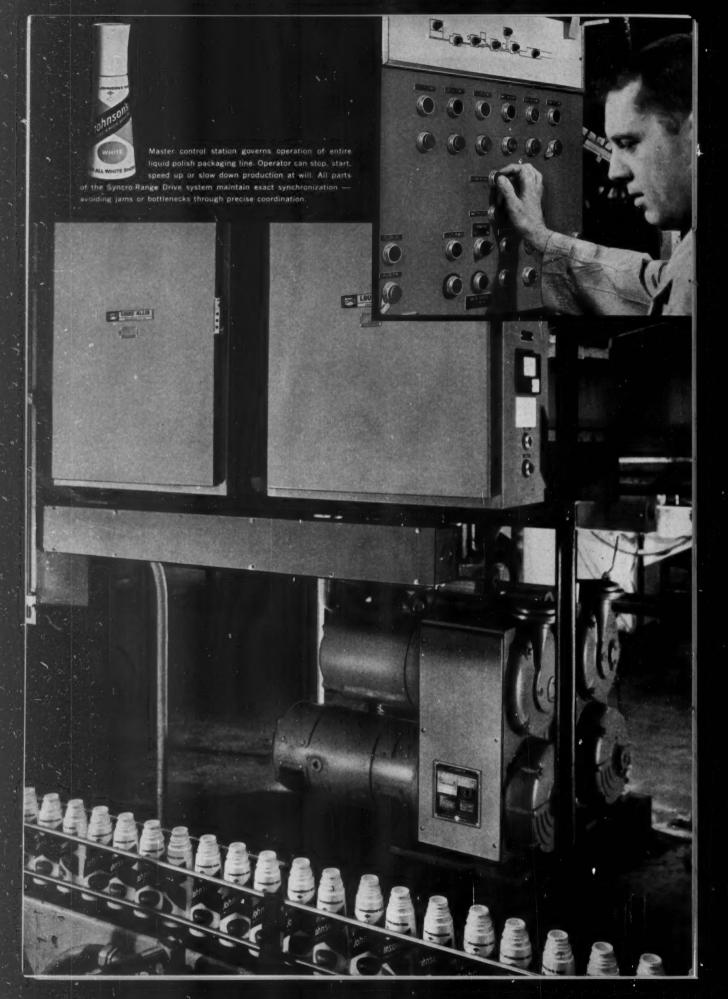
Write today for our free 1824 booklet giving the full benefits you can expect from an 1824 Printer. XEROX CORPORATION (formerly Haloid Xerox Inc.) 61-173X Haloid St., Rochester 3, N. Y. Branch offices in principal U.S. and Canadian cities. Overseas: Rank-Xerox Ltd., London.

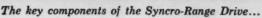
XEROX



TO matter where you are, it's on its way within 24 hours after we receive your order, when it's Timken® 52100 tubing. Such fast service on less than mill quantities is possible because we stock 101 sizes -from 1" O.D. to 101/2" O.D. And you can get the same fast service on 50 sizes of 4620 tubing. Modern warehousing makes it all possible. To save time and money on your constructional parts, remember that 90% of them can be made from either of these two Timken steel analyses. For details, send for our free booklet, "Alloy Steel Mechanical Tubing Stock List". The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO" Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

TIMKEN
FINE STEEL











... and Standard or Syncro-Spede Motors!

LOUIS ALLIS SYNCRO-RANGE DRIVES automate liquid polish lines

Johnson's Wax, renowned wax and polish producer, uses Syncro-Range Drives for exact control of process lines

Controlling speed of the precise, mass-production lines for their new, highly successful liquid shoe polish was the task Louis Allis engineers had to solve for Johnson's Wax,

The problem was to time the flow of plastic bottles, liquid polish, wool daubers, and caps into the packaging lines at precisely equal rates. Flow rate must be adjustable so the lines can be slowed down or speeded up. And the entire packaging operation must be controllable from a single master control. The Louis Allis Syncro-Range Drive solved the problem.

Syncro-Range Drives provide synchronized speed of any number of motors from a single control. It is a "packaged system" comprising an adjustable-frequency power supply operating on 3 phase, 60 cycle power input...a group of Syncro-Spede® synchronous motors which maintain exact synchronism regardless of varying load...and a control which permits the speed of the entire group of motors to be simply adjusted without losing synchronization. On applications for which exact synchronism is not required, standard squirrel-cage motors can be supplied.

You can readily see the advantages of the Syncro-Range Drive in systems or processes which require synchronized movement: multiple conveyors which feed consecutively; transfer lines; process lines; assembly lines requiring coordinated arrival of components; printing where one press feeds another; synthetic fibre spinning, drawing, or twisting; metal runout tables; and many other similar continuous-process machines which require the application of power at a number of points on the machine.

The Syncro-Range Drive is available with a choice of drive sizes to efficiently control from 2 to 200 (or more!) standard or Syncro-Spede motors of the same or different horsepower ratings. The Syncro-Spede motor is an A-C synchronous induction motor without slip rings or D-C excitation. It requires no more upkeep than a standard, squirrel-cage motor and can be supplied in open drip-proof, enclosed, or explosion-proof enclosures with mechanical modifications to match your requirements.

A sophisticated selection of control features are available in the system, including motor starters, main line circuit breaker or fusible disconnect switch, speed adjustment, speed indicator, remote control, and automatic control governed by temperature, pressure, or flow sensing devices. Controls can provide speed regulation accurate to 0.1% with 0% relative speed difference between motors!

Investigate the application of the Syncro-Range Drive system to your process. A trained Louis Allis motor application engineer is always available. You can reach him at your local Louis Allis District Office, or by writing direct to The Louis Allis Company, 459 East Stewart Street, Milwaukee 1, Wisconsin.



MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

LOUIS ALLIS

A design engineer tells . . .

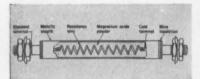
How we design General Electric Heaters to meet your rigid quality specs

T. Skogland, Supervisor, Production Engineering, Industrial Heating Dept., General Electric Co.

The approach to heater design is basically one of matching long life with optimum cost. Does the application require a few minutes ultra-dependable operation on a missile, or many thousands of hours in typical industrial use? Then these four points must also be closely considered: 1) environment—including temperature, chemical content, and physical abuse; 2) heat output; 3) size; and 4) special application requirements.

LONG LIFE FIRST OF ALL

In our Calrod* tubular heaters, for example, we know we have a basic design which gives long, dependable life. The cutaway shows construction features which make these heaters resist physical abuse. For instance, the heating element is encased in rock-hard magnesium oxide insulation and a strong metallic sheath.



General Electric tubular heaters are designed for maximum durability.

The choice of sheath material depends on the environment. For water we usually recommend a copper sheath; for cast-in and low-temperature applications, a steel sheath; higher temperatures normally require a stainless steel or other alloy sheath for greater oxidation-resistance.

Where corrosive liquids will be encountered, we recommend corrosion-resistant sheath materials. These might be steel, stainless steel, a special alloy, or

THE HEART OF THE HEATER

Inside the sheath there are other decisions to be made. We select our resistance wires to match the internal heater temperature ranges for the application. Some of the wires used are 80 Nickel, 20 Chrome; 60 Nickel, 16 Chrome; and the Aluminum Chrome Ferrous types. And for insulating material we use magnesium oxide powder with its high dielectric strength and excellent thermal conductiv-

Once the right amount of heat is specified, we then want to be sure heat distribution is uniform along the entire effective heating length of the heater. Our

*Registered Trademark of General Electric Co.

machines for winding and stretching the helical resistance coils are specially designed to provide consistently uniform heat distribution.

SPECIAL SHAPES AND ACCESSORIES

Special applications often require special shapes. To meet your needs, General Electric tubular heaters can be bent into virtually any configuration. One limitation is that the bending radius cannot be less than the sheath diameter. Again, special equipment and highly trained personnel enable us to produce formed heaters consistent in size and shape. The example of a formed heater you see here appears extreme, but we've formed many which are even more complex.

Accessories are often required to permit easy heater installation. Usually you can choose from our time-tested selection of terminals, seals, bushings, etc. However, there are times when a standard won't quite do the job for you. Our experience helps us design and manu- General Electric Calrod facture custom- tubular heaters can be made accessories to formed to almost any meet your specifi- configuration. cations.



For instance, we have standard terminations from staked-on threaded stud type to side-projection-welded screw type. And this selection includes quickconnect types. The variety of other terminals we can design for you is almost limitless.

When the heater is applied in liquids or a gaseous atmosphere, sealed terminations become important to the design. The selection will depend on the operating temperature, and whether a true hermetic seal or merely moisture retardation is required. Some of the terminations we use are molded rubber, plastic resin, silicone, and ceramic-to-metal.

MUST PERFORM WELL, LOOK WELL

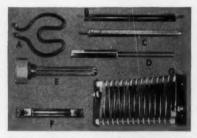
We feel that a heater should both perform well and look well. Our mechanical,

electrical and visual inspections provide you with just that. There are tests for wattage, insulation resistance, appearance, and key physical features. These tests performed according to rigid preplanned quality control standards, are an integral part of our production line.

When we have made sure that your heater is designed to meet your specifications and can be manufactured, the next logical subjects are price and delivery. These are especially important for your purchasing group. Whenever I've discussed price and delivery with our sales and application engineers they've been very emphatic in their assurances that they can meet any reasonable delivery requirement, and quote competitive

As a design engineer, my own feelings about component prices are these: When a component represents a major part of a product's total reliability but only a minor part of the total cost, I will argue for any reasonable price differential to make sure the best component is purchased. I want my product to be reliable.

If you are designing heat into your product or process, we can help you select the right heater for your specific need. Please send complete details to Section 757-07, General Electric Co., Schenectady 5, N. Y. or your local G-E sales office. I will work closely with our sales and application engineers to develop the right heater to meet your specifications.



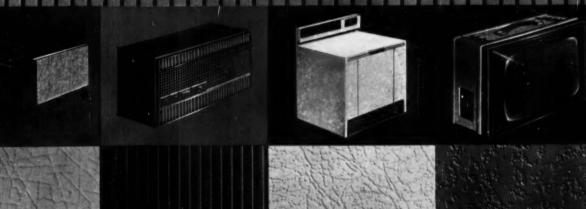
High reliability is designed into all G-E Calrod heaters: tubular (A); vane (B); finned tubular (C); cartridge (D); immersion (E); strip (F); and oven (G) heaters.

Progress Is Our Most Important Product



PATTERN

PITTSBURGH STELL SHEET



Wrapper stock or drawn parts, flat panels or roll-formed fittings—whatever the application, Wide Pattern Designed Sheet gives finished products snap and sparkle that attract buyers, boost sales. Patterned Sheet—as wide as 60 inches, thicknesses from .0179 to .0897 inch—is available in commercial, drawing and AK drawing quality steel; has same fabricating properties as plain cold-rolled sheet in your processing equipment. Rolled-in designs—unlimited in range—take paint, enamel, porcelain, plated finishes. Investigate Wide Pattern Designed Sheet—steel with decorative appeal, from . . . PITTSBURGH STEEL COMPANY, Pittsburgh, Pa.



HOW "BOSTON" PROFITS FROM THOMAS NICKEL-COATED STRIP

Thomas Strip buffed nickel-coated steel strip reflects 40% saving, fewer production steps for C. Howard Hunt Pen Co.'s pace-setting "Boston" pencil sharpeners.

At Statesville, N.C., Hunt Pen blanks, embosses, pierces, spot-welds wrapper stock for sharpener cases from coils of 2 by .010-in. buffed nickel-coated steel. Firm has depended on Thomas Strip Division of Pittsburgh Steel Co. 20 years for brilliant finish. Purchasing Agent T. V. McCurdy tells why:

"We once used stainless for wrapper stock but costs skyrocketed. Thomas Strip costs 40% less, gives us handsome appearance, durability and easy fabrication of steel. It eliminates expense and headaches of plating, too.

"We're more critical of this material than any other—the slightest scratch stands out. We've never had to reject any during our long relationship with Thomas."

Hunt Pen produces more pencil sharpeners with nickel-plated strip than any other U.S. manufacturer. Assembly of "Champion" portable model is shown above.

Want to learn how Thomas Pre-Coated Strip Steel Specialties can help you? Ask, and we'll show you.

"WE GET BETTER PRODUCTS FOR LESS WITH THOMAS PRE-PAINTED STRIP," SAYS NATIONAL GYPSUM COMPANY

Tough, durable vinyl-enamel coat on Thomas Pre-Painted Strip fabricates easily as plain steel, gives a profitable boost to "Gold Bond" quality of National Gypsum Company's metal building products.

Exposed pre-finished partition bases, cornice moldings, wall trim and "J" suspension channels are roll-formed by National Gypsum Company's Niles, O., Metal Building Products plant. Coiled strip sizes range from 18 to 24 gage in widths 2^{11} /₂ to 4^{1} /₂-in., painted one side with white, grey or red, and wash-coated opposite side.

"Thomas Strip Pre-Painted gives us products far superior to those we got when we spraypainted after forming. It saves us 8.75 to 9.2% of production cost and reduces inventory problems," says Plant Manager D. K. Archer.

"The paint coat has better adhesion and takes roll forming without cracking or peeling. Thomas supplies us superior material of uniform, consistent quality that suits our requirements."

Photo below: roll forming 10-ft. Snap-On bases.

Eliminate your paint-line problems with Thomas Pre-Painted Strip. Let us show you how.





SQUEAKS, RATTLES SILENCED WITH THOMAS PLASTIC-COATED STRIP

Primary use of Thomas Plastic-Coated Steel is in decorative applications. But it performs a unique practical task for manufacturers of fine furniture.

Laminated to Thomas cold-rolled strip, the plastic coating assures absolutely noiseless functioning of modern, strong steel springing.

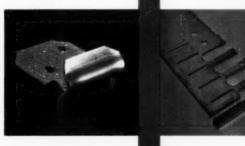
Universal Wire Spring Division of Hoover Ball & Bearing Co., Georgetown, Ky., uses Thomas Plastic-Coated Strip to make spring retainer clips that anchor its sinuous wire Uni-Torq and Uni-Flex springs to furniture frames.

"We tried applying pressure-sensitive tape to steel for this clip, but decided on Thomas Plastic-Coated. It's pre-finished and doesn't slip or peel in forming or in use," says Bernie J. Johnson, sales vice president, upholstery spring division.

"The clip acts as a pivot as well as an an-

chor for our engineered seating springs. Steel against steel produces squeaks and rattles. The plastic coating eliminates them—and makes an important sales point."

Decorative or functional
—whatever the need,
Thomas Steel Specialties
will make your product
better, too.



THOMAS STRIP HELPS "BUILD A BETTER MOUSETRAP"



World's biggest trapmaker, Animal Trap Co. of America, has the long-sought "better mouse-trap." And Thomas Strip Copper-Coated Steel helps make it so. Rattraps, too.

Animal Trap Co. of America, Lititz, Pa., has depended on Thomas Strip over 25 years for close tolerance copper-coated steel strip to make bait pedals, locking bars for a dozen models.

The firm produces millions yearly from Thomas electroplated stock in sizes from .4375 by .025-in. to 5 by .035-in., #2 temper. Precise tolerances, consistent temper of base steel allow long, trouble-free runs through progressive dies, automated assembly lines.

"Base steel gives strength, economy—the

planished copper finish provides appearance and corrosion resistance needed to out-sell cheap foreign-made traps," says Sales Vice President D. S. Morrison.

Want the world to beat a path to your product's door? Thomas Strip plain or coated steel specialties may be what you need. Ask.



BRASS-COATED THOMAS STRIP SAVES FOLDING-RULE MAKER 60% IN METAL COST

Thomas Strip Brass-Coated steel measures up to strict cost, tolerance, strength and appearance standards for Evans Rule Co. of Elizabeth, N.J., leading producer of measuring rules and tapes.

An improved type of wood folding rule—assembled with 11 patented spring joints, fabricated from Thomas electro brass-coated strip—is produced for Evans by a subsidiary—Fabrule Co.—in a fully automated plant.

For rule joints, Evans buys two sizes of Thomas brass-coated strip—1.812 and 1.562 in. wide by .012-in. thick, #3 temper, planished and oiled.

"Brass-coated strip saves us about 60% over what we'd pay for pure brass for rule joints," says John J. Evans, board chairman.

"Besides that, the base steel supplies strength to take abuse, as well as rigidity needed when the rule is opened. The brass coat provides

> protection against corrosion and the planished finish results in a sales boosting appearance. Physically, width and temper uniformity is critical for processing through our automated lines."

Do expensive metals hike your product cost? Inquire how Thomas Strip pre-coated steel can help you save.



The STEELMARK on a product tells you it is made of steel. Look for it when you buy.



NEW-BRUSH PATTERN DESIGN FOR THOMAS PRE-COATED STEEL

Here's a **brand new** addition to Thomas Strip Division's wide range of pre-coated and pattern designed finishes for decorative applications.

Called "Brush Pattern Design," this new Thomas Strip specialty reduces finishing costs, enhances sales appeal through its deep, lustrous, textured and buffed surface—offers products attractive "plus" that influences buying decision, moves items off the shelf.

"Brush Pattern Design" is cold-rolled strip electroplated with copper, brass, nickel or zinc coating, buffed to soft highlighted finish,

protected by clear lacquer.

New Thomas Strip technique produces Brush Pattern Design Strip with uniform, nontarnishing plated coating across entire surface. Fabricates easily, without distortion of pattern finish.

Reduce your product's finishing costs, improve its appearance with Thomas Brush Pattern Design. Thomas experience, design help is yours for the asking. Call or write.



THOMAS STRIP DIVISION PITTSBURGH STEEL COMPANY

Grant Building · Pittsburgh 30, Pennsylvania



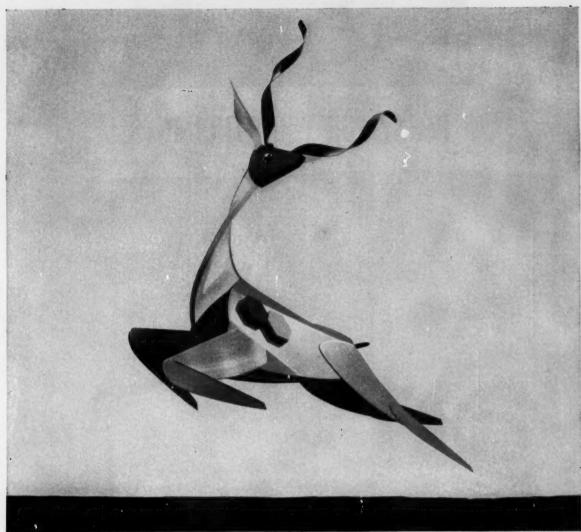
Atlanta

Chicago Cleveland Dallas

Dallas Dayton Detroit Philadelphia Houston Pittsburgh Los Angeles Tulsa

New York Warren, Ohio

DISTRICT SALES OFFICES



Original sculpture created for 3M Co. by Guy Palazzola

Freedom

... New design concepts "take off" with 3M Brand Adhesive Products!

Want to escape design limitations imposed by old-fashioned fastening ways? Help yourself to new elbowroom with the modern, clean-lined, functional fastening you get with 3M Adhesives!

New simplicity! Using 3M Adhesives for assembly, you eliminate fasteners, nuts, bolts, rivets, staples. Fewer parts give you simpler construction that costs less, looks better. The making of necessarily complex shapes and castings, too, is simplified by 3M Adhesives; you break down the complex part into several simple sections, then adhesive hond into one

adhesive-bond into one.

New material choices! With 3M Adhesives you bond practically any material to itself or to any other material. Metals (including magnets), woods, glass, ceramics, plastics, the whole works! Lighter gauge materials can be used because adhesives eliminate local stress concentrations, in-

crease joint strength. The integrity of joined materials is unimpaired because holes (for fastening devices) and heat (for fusion), are aliminated

fusion) are eliminated.

New production savings! With the increasingly close liaison between industrial designer and production engineer, the many production savings inherent in adhesive bonding favor the design that employs 3M Adhesives. For a realistic appraisal of what 3M Adhesives can do to give you more design freedom, better production economics, call your nearest 3M Field Engineer or write to: AC&S Division, 3M Company, Dept. SBR-61, St. Paul 6, Minn. "Scotch-weld" is a Reg. T.M. of 3M Co. @3M Co., 1961.



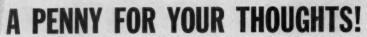
What do you want to bond to what?
The 3M Gazelle is fabricated of these materials and bonded with 3M Adhesives, including SCOTCH-WELD® Brand Structural Adhesives;

Brass 2. Wood 3. Plastic 4. Ceramic 5. Copper 6. Stainless Steel 7. Aluminum.

ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY
... WHERE RESEARCH IS THE KEY TO TOMORROW







Design an aluminum extrusion, win \$2500, \$1000 or one of five \$100 awards.

SOME WORDS OF ENCOURAGEMENT

It makes no difference whether your design idea is only now budding in your imagination, nurtured on your drawing board . . . accepted, rejected or utilized by your company. All designs using aluminum extrusions are welcome.

Whatever you're designing now, complete product or component part...try redesigning it using aluminum extrusions. Maybe a sticky design problem can be solved by developing a never-before-extruded shape that will take the place of a machined, formed or welded assembly, or one that, when sawed into sections, will reduce machining cost... or provide other product benefits.

First Place Winner Will Receive \$2500. Runner-Up Will Win \$1000. And Five Third Place Entries Take \$100. each. All Entrants Receive a Bright, New Penny!

THE JUDGES AND HOW THEY CAN HELP YOU WIN

The top twelve designs selected by Kaiser Aluminum will then be finally judged by executives of the Independent Extruders listed on the opposite page. Your entry will be judged on the basis of originality of concept, product improvements, production cost and time savings, and other resultant or projected advantages that aluminum extrusions make possible.

For a better idea of the vast applications for extrusions and for any technical assistance you may need, contact the Independent Extruder nearest you (see list on opposite page). You can call on his and Kaiser Aluminum's vast extrusion experience to give you expert technical guidance in selection of alloys, tolerances, mechanical properties, tooling and extrusion costs.



A PENNY FOR YOUR THOUGHTS!

Signature of Entrant_

ENTRY BLANK

- One \$2500, one \$1000 and five \$100 awards will be made by Kaiser Aluminum & Chemical Corporation for the extrusion designs submitted and judged to be the first, second and five other best designs submitted. Decision of the judges will be final.
- All designs submitted must be postmarked before midnight August 31, 1961.
- 3. Each entry and its subject matter shall be the property of Kaiser Aluminum. Entrants accept these rules when submitting their entries, and agree that Kaiser Aluminum may use the entries in any manner without restriction and without payment or any other obligation to the entrant except to the extent set out in Paragraph 1 above.
- Contest is open to all persons except employees and families of Kaiser Aluminum & Chemical Corporation, Kaiser Aluminum & Chemical Sales, Inc. and independent extruders.
- No entry will be accepted unless accompanied by a signed contest entry blank, addressed to:

PENNY FOR YOUR THOUGHTS CONTEST Kaiser Aluminum & Chemical Corporation Kaiser Center, Room 847, Oakland 12, California Date____Company____

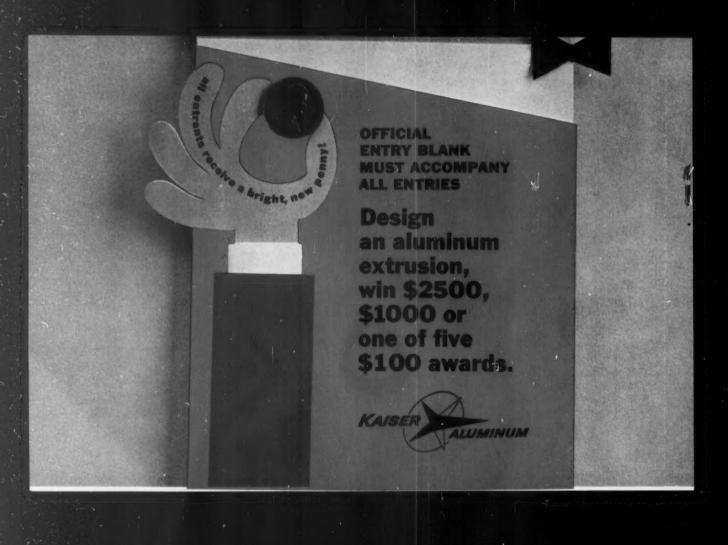
Title___Address___

City___Zone_State___

Additional entry blanks are available from the independent extruder nearest you.



Kaiser Center, Oakland, California
See HONG KONG and MAVERICK weekly,
ABC-TV Network



No Contest Is Complete Without Clues

To help you get started on your winning design . . . here are just a few examples of extrusions and the parts they replace.



BETTER HEAT TRANSFER . . . The extrusion process makes possible the integral shape shown at right, above. This design provides greater area for heat transfer and minimizes assembly costs.



LOWER WEIGHT, FASTER ASSEMBLY . . . Several different shapes can often be combined into a single extrusion. The integrally stiffened panel above, right, weighs less, reduces joining cost.



GREATER DESIGN FREEDOM . . . This gunwale provides structural strength as well as good appearance. Made as an extrusion, it provides for interlocking, decorative and utilitarian bumpers as well as color strips. No other process allows the styling and low upkeep possibilities found with Aluminum Extrusions. And extrusion dies are inexpensive compared with tooling costs for other types of fabrication. Fasteners are hidden and no welding is necessary.



LESS MACHINING . . . The low inertia hollow rotating member is manufactured from a close tolerance extrusion. It is sawed into sections from a continuous profile rather than from machined castings or bar stock. The extrusion process reduces expensive tooling, scrap and production time.

Now Start Thinking And Designing... It Could Mean Cash For You!

How To Submit Your Winning Entry.

- 1. All drawings and descriptions must be submitted on white paper no larger than 16" x 20" with the name of your extrusion design and your name and address typed or printed on the upper left corner of each page. Official entry blank must be included.
- 2. Each design submitted must clearly show the functional purpose of the extrusion.

MASSACHUSETTS

Watering

Lawrence

Titus Metals Corp.

Northeast Aluminum, Inc.

- 3. Include a description of your design, its purpose and advantages and any comparisons between the new design and the product or component it might replace.
- 4. Photographs of existing components, products or your new design may be submitted along with your entry.
- 5. Contest entries must be postmarked before midnight, August 31, 1961. Winners will be notified by mail before November, 1961.

CONTACT THE INDEPENDENT EXTRUDER NEAREST YOU for expert advice on all extrusion problems or for additional entry blanks.

ARKANSAS			Royce Aluminum, Inc.	Taunton	VA 4-8631	0	ню	
Southern Extrusions, Inc.	Magnolia	CE 4-4260	Trim Alloys, Inc.	Boston	AN 8-5200	Alsco, Inc.	Akron	BL 3-7701
						B & T Metals Co.	Columbus	CA 8-5411
CALIFORNIA		MICHIGAN				ampbell	PL 5-9679	
The Aluminum Extrusion C	o. Los Angeles	CL 5-1511	Aluminum F trusions, Inc	. Charlotte	543-2010	General Extrusions, Inc.	Youngstown	ST 8-9681
American International	San Jose	CY 8-1606	Brazeway,c.	Adrian	CO 5-2121	Magnode Products, Inc.	Trenton	YU 8-6331
B & T Metals Co.	Los Angeles	RA 3-4501	Detroit Gasket & Mfg. Co	Belding	KE 1-3400	National Extrusions & Mfg.		LY 2-9010
Jotaco Extrusions, Inc.	Orange	KE 2-6331	Ferguson Extrusions, Inc.	Detroit	TE 4-5081	F. A. Pilgrim Co., Inc. Saramar Aluminum Co.	Youngstown Youngstown	ST 8-4077 SW 9-9741
Michael Flynn Mfg. Co.	City of Industry	CU 3-6407	Light Metals Corp.	Grand Rapids	RI 2-3481		Hartville	TR 7-9307
Pacific Extrusion, Inc.	Watsonville	PA 4-2244	Midwest Aluminum Corp.	Kalamazoo	FI 5-8155	F. E. Schumacher Co., Inc. Weather-Seal, Inc.	Barberton	SH 5-2114
Pax Metal Corp.	Van Nuys	TR 3-2720	North American Extrusion		FI 5-8610	Youngstown Mfg., Inc.	Youngstown	RI 3-1161
Texas Aluminum	Mojave	VA 4-4021	Purpose Extruded Alumini		HI 8-2551	roungstown mig., inc.	Loongatown	W1 3-1101
			Quality Aluminum Product		BR 8-2381	PENNS	YLVANIA	
FLORIDA		Rogers Industries	Detroit	VE 8-7500			BA 3-7700	
American International Al-	uminum Corp. Miami	NE 4-8591	Valley Metals Products Co	o. Plainwell	MU 5-8711	Airmaster Phili Michael Flynn Mfg. Co.	adelphia Philadelphia	FI 2-5500
General Aluminum Fabrica	tors Miami	TU 7-8231					Erie	TE 8-1931
Miami Extruders, Inc.	Miami	OX 1-8900	м	ISSOURI		Pittsburgh Aluminum Alloys		BR 1-4744
Regal Extrusion Corp.	Miami	NE 3-8128	Hazelwood Engineering &			R. D. Werner Co., Inc.	Greenville	IU 8-8600
Ware Laboratories, Inc.	Miami	NE 4-8511	Equipment Co. Haz	relwood (St. Louis)	PE 1-2274	R. D. Weiner Co., Inc.	At Collaine	10.0-0001
	EORGIA					SOUTH	CAROLINA	
_				W JERSEY		Extruded Aluminum Co., Inc	. Summerville	TR 3-2381
Loxcreen Co., Inc.	Chamblee	GL 7-6394	Corson Industries	Delair	NO 2-5500			
			Mideast Aluminum Corp.	Dayton	DA 9-8113	TI	EXAS	
11.	LINOIS		New Jersey Aluminum Ext			Sauer Aluminum Co.	Dallas	AD 5-2357
Kinkead Industries, Inc.	Chicago	IN 3-7800	Warner Mfg. Corporation	Bloomfield	PI 8-5000	Texas Aluminum Co., Inc.	Daltas	RI 1-3361
Mala Extrusions, Inc.	Rock Island	8-9396				reads Areinment Co., The.	Danas	W. T. 2007
Precision Extrusions, Inc.	Bensenville (Chicago) NA 5-4600	NE	W YORK				
			Alan Scott Aluminum	Westbury	ED 4-1800			
	ADIANA		Aywon Wire & Metal Corp	. Brooklyn	TE 9-1000			
Greater Louisville Industr			Badger Aluminum Extrusion		NI 9-6400		~	
Mainline Extrusions, Inc.	South Bend	AT 8-9244	Empire Extrusions Corp.			^	1	
Wells Aluminum Corp.	North Liberty	OL 6-8111	Jarl Extrusions, Inc.	E. Rochester	LU 6-2660	Maroco		
			Jasco Aluminum Products			KAISER		*
	IOWA		Div. of Irving Air Chute		FI 3-4300		ALUMIN	UM
Titure Manhala Corn	Makadaa	AD 4 1771	lerey Cornoration	Amityville	MY 1-7270			

NORTH CAROLINA

Jerex Corporation

Carolina Aluminum Co.

AD 4-1771

MU 3-2718

MY 1-7270

EL 8-4071

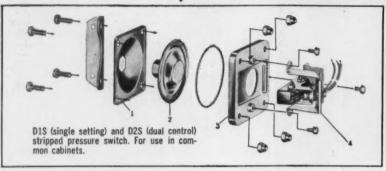
nical Corporatio

"New leadership in the world of aluminum"

Amityville

Winton

How to put 50% more accuracy into a pressure switch at 25% lower price



The accepted standard of accuracy in pressure switches is $\pm 1\%$. The new Barksdale diaphragm pressure switches are guaranteed for $\pm 0.5\%$ set and re-set accuracy ($\pm 0.2\%$ if required). This instrument accuracy, unique proof (test) pressure characteristics, and remarkably easy servicing are accomplished by the use of a "basic unit" diaphragm assembly to which components are attached as required. The erector set principle permits production economies that are reflected in substantially lower prices. The entire concept of Barksdale pressure switches is the result of desired specification improvements as outlined by representatives of varied industries who were consulted before designing was begun.

The versatile basic unit

The basic unit of all Barksdale pressure switches is a leakproof, welded-metal sensing element (No.2 in the photograph above) surrounded by a heavy protective capsule (Nos. 1 and 3) which is independent of the sensing and switching elements. The hex pressure connection of the diaphragm element fits into a hex opening in the base of the capsule, preventing damage to the diaphragm should the unit be twisted during installation or removal. The standard pressure connection is ½" npt female pipe fitting; ½" npt fitting is available when specified. The latter was requested by the petroleum industry to facilitate removal of paraffin accumulation and to permit attachment of switches directly to ½" pipe.

Diaphragms easily removable

Diaphragms may be removed without disturbing switch wiring, thus making it possible to change diaphragms to accommodate varying pressure requirements or to substitute diaphragms of different metals as fluid characteristics may demand. This feature cuts inventory costs for original equipment manufacturers because they need stock only diaphragms to meet their various pressure requirements rather than to stock complete switches in every category. It is important, also, to the petroleum industry because only diaphragms (not entire switches) need be carried by personnel doing field service.

Proof (test) pressures to 300 psi

The upper and lower sections of the diaphragm capsule are molded to fit the sensing element exactly. The top section prevents the diaphragm from stretching beyond normal curvature when surges above system pressure are encountered, and there is no possibility of metal distortion that would affect switch accuracy. In the low settings the 'new Barksdale pressure switches will actuate at 0.1" mercury with proof (test) pressure to 10 psi. In higher ranges they will go up to 300 psi proof (test) pressure at settings to 150 psi.

Stripped switch (single and dual control)

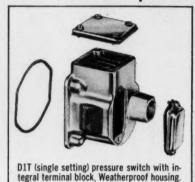
Addition of a switching element (No. 4 above) to the basic diaphragm unit makes a stripped switch for use in a common cabinet with other electrical devices. Original equipment manufacturers need not pay for unneeded housings. Single and dual switching elements are available, and extremely fine adjustment is possible because the adjusting screws have 64 threads to the inch. Adjustment may be made with a screwdriver, or a wrench may be used on the hex head of the adjusting screw to provide extremely fine adjustment.

Standard, terminal block, and explosion proof housings

Addition of a sealed housing (standard, terminal block, or explosion proof) to a stripped switch completes a pressure switch that can be ordered "tailor made" for any desired application. All Barksdale pressure switch housings offer distinctive advantages. In the standard housing, free wire leads are through a ½" nps conduit conductor. Wires are held firmly in place by a special tension clip that prevents disturbing the switch adjustment through careless wire handling. Terminal block housings are available for wiring convenience. Pottable electric outlets are provided on explosion proof housings, and the external adjustment feature incorporated in these housings was suggested by the petroleum industry. Servicing instructions on all Barksdale switch housings are on the inside of a tamper proof cover to allow for painting of units.

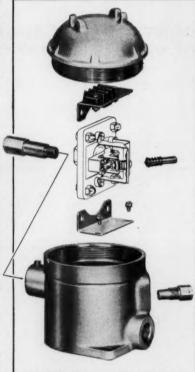
Ask for new catalog

New Barksdale diaphragm pressure switches offer you something new in accuracy, proof (test) pressure, and economy. The just-printed catalog tells the complete story. Ask your Barksdale representative or write to Barksdale Valves, 5125 Alcoa Avenue, Los Angeles 58, California.

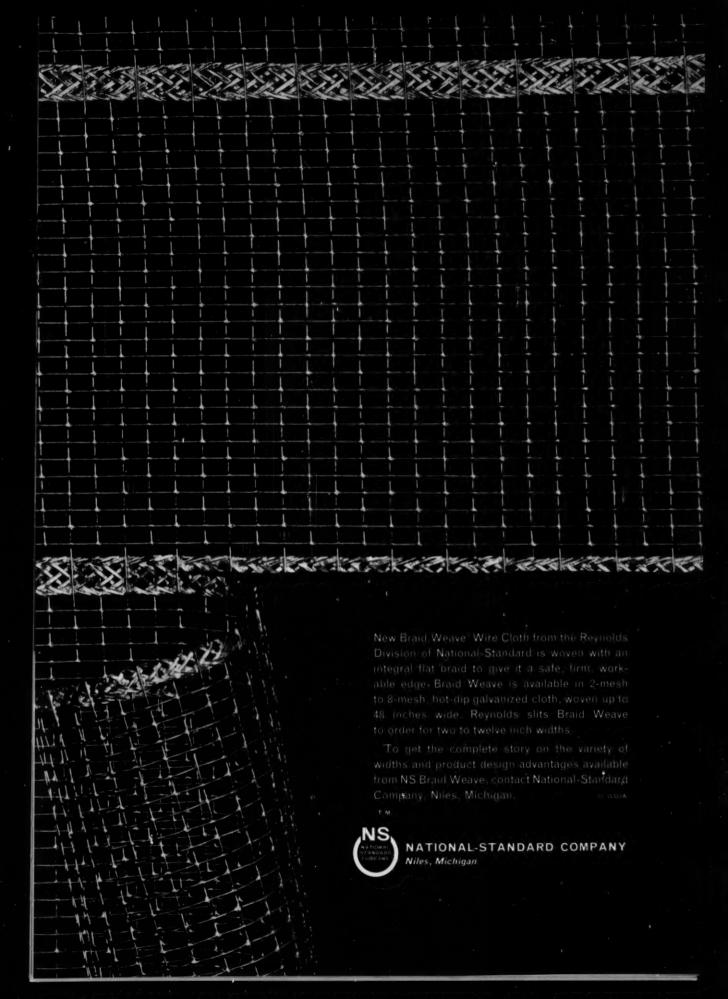




D1H (single setting) and D2H (dual control) pressure switch with standard housing. Weatherproof.



D1X (single setting) and D2X (dual control) explosion proof pressure switch. Pottable electric outlets. External adjustment.





NS SPECIAL WIRE TRANSMITS

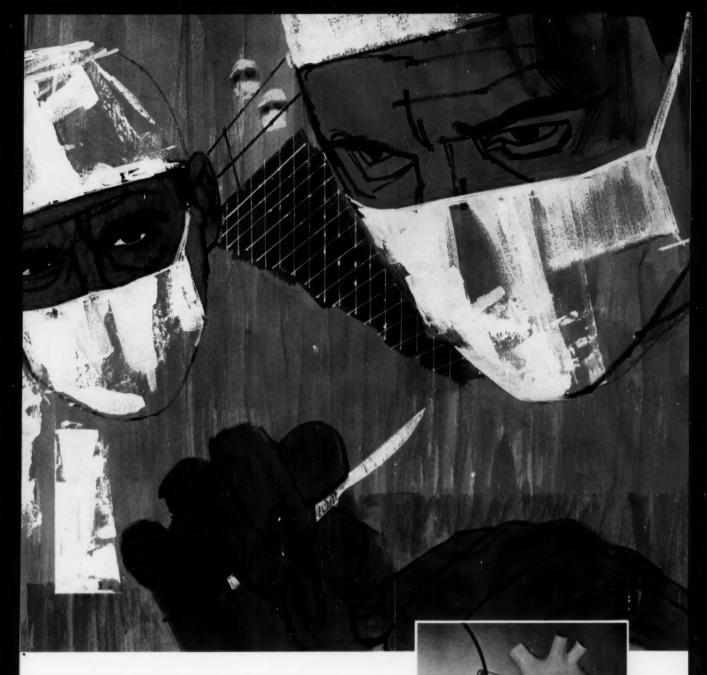
Doctors are saving more lives today in heart surgery cases through the transmission of carefully timed electrical pulses into the heart. Many patients suffering from lost heartbeat due to surgery or other causes have been restored to active life through such heart stimulation.

A LEADING MEDICAL INSTRUMENT COMPANY developed a pocket-size electronic package to generate the electrical impulse, which is transmitted to the heart through the jugular vein by a tiny stainless steel braided wire.

In their search for the right conductor to carry

the electric pulses to the heart, researchers came to National-Standard for help in developing a wire flexible enough to follow the intricate path of the circulatory system, while, at the same time, soft enough to avoid damaging the blood vessels or the heart itself. In addition, the wire had to be very thin, strong enough to withstand the constant flexing of the heart, and with just the proper electrical characteristics.

NATIONAL-STANDARD ENGINEERS developed a braid of 16 wires, each .0036" diameter, or about the thickness of human hair. Using type 302 stainless



SPARK OF LIFE

steel wire, NS engineers produced a braided wire with high tensile strength, good resistance to fracture, good conductivity and flexibility just right for the delicate application.

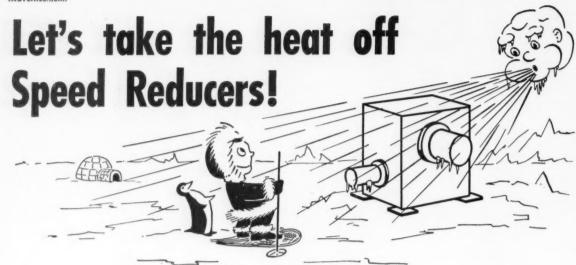
EXPERIENCED ENGINEERING HELP of this kind, for jobs requiring high-quality wire, to meet special or unique applications, is available to you from National-Standard. Write for additional information to National-Standard Company, Niles, Michigan.



Manufacturer of Specialty Wire and Metal Products

NATIONAL-STANDARD COMPANY
Niles, Michigan

NS SPECIAL WIRE transmits spark of life from transistorized, battery-powered package, through jugular vein, to the heart. Carefully timed electrical pulses train tired hearts to beat normally again.



A worm gear speed reducer is one of the toughest little customers in captivity. It reduces speeds day-in, day-out, with little complaint. While it works long and hard, it has limitations—set by ratio, center distance, RPM, mechanical and thermal HP ratings, etc. And, depending upon how precisely it was selected and fitted to the job requirements, it will do what it has to do.

But sometimes it's forced to play outside of its league. It must cope with job requirements that vary from here to there—normal 8 to 10 hour service without recurrent shock, the same length of service where there is some shock loading, continuous low-speed service and almost countless others. But the thing that really puts the pressure on reducers, the thing that's lurking in *every* set of job requirements—is h-e-a-t.

When you exceed the thermal capacity of a reducer for more than an hour or so, excessive temperature thins the lubricant resulting in wear; material, bearing and oil seal failures; etc. Of course, the proper lubricant will help but it can't cure the continuing problem of excessive heat.

So how can we lick this toughy? One way is to build the reducer housing oversize, big enough to radiate the heat away and keep temperatures down. But this type sticks out in aisles, louses up compact designs and barks shins. Then, we might try a smaller housing complete with fins on it to dissipate the heat. If this still doesn't work, another trick is to use a reducer with capacities and ratings a step above the ones we need. This is sending a man to do a boy's job. It's impractical, inefficient

and costly. There has to be an easier, better, saner and cheaper way to do it. And there is!

In certain cases, where the size and type of reducer permits and where we can gain enough in thermal HP rating to keep heat generation in bounds, Cone-Drive Gears does it with fan-cooling.

What's that? Simple. Just add a fan to the worm shaft plus the necessary air shields, fan cover, etc., and presto!—heat is no longer a problem. The air shields direct the fan-pushed air over the fins on the lower portion of the reducer. The fins are shaped and spotted to guide the air stream where it is needed. Thermal HP ratings are boosted tremendously, as high as 147% above those of standard reducers in some cases! Those over-worked, over-heated reducers will now do the job you bought them to do.

Other advantages? They're here in abundance. The size of the reducer stays the same. All parts on a Cone-Drive fan-cooled reducer are 100% interchangeable with parts for standard reducers. Oil capacity is identical. Shields are quickly removed without disconnecting the reducer. (This is important where severe operating conditions make periodic cleaning necessary). The reducer can also be operated without fan-cooling just by taking off the fan and shields.

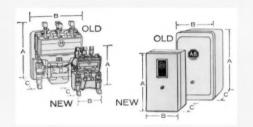
This simple addition to standard Cone-Drive HU speed reducers might be just your answer—might save you some money. Write for Cone-Drive's Bulletin CD-218. It will tell you all about the full line of Cone-Drive double-enveloping worm gear reducers as well as the fan-cooled kind. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.



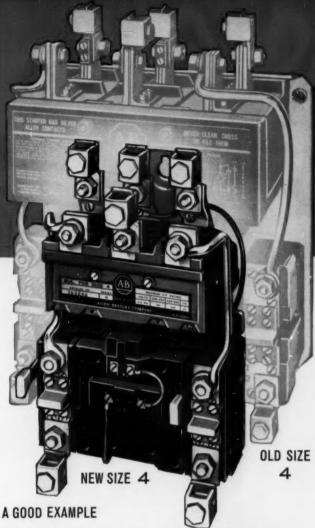
You get BIGGER PERFORMANCE

Plus SMALLER SIZE

with the new Allen-Bradley Bulletin 709 Starters



14-61-RM



The new revolutionary Bulletin 709 motor starters are surprisingly small in size—yet, they are good for many more millions of operations—without trouble or maintenance! Rating for rating, they have no equal. They are today's best starter value—and they cost no more!

The "Quality" you've come to expect in all Allen-Bradley control is represented in all details—especially in the "eye appealing" enclosures styled by the world famous industrial designer, Brooks Stevens. Write today for details of the new Bulletin 709 line—the greatest advance in motor control in 30 years: Allen-Bradley Co., 1316 South Second Street, Milwaukee 4, Wisconsin.

Check These New SPACE-SAVING Dimensions

Starter Size		OPEN TYPE STARTERS						NEMA 1 ENCLOSURES					
	Height A Wid		ith B Depth		th C	Height A		Width B		Depth C			
	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	
00	35/8		31/8	-	3%6	-	75/8	-	41/8	-	41/4	-	
0	51/8	55/8	41/16	43/4	311/16	31/4	91/8	71/8	65/16	55/8	43/8	41/4	
1	65/8	51/8	41/2	5	311/16	31/4	10	813/16	613/16	6%	43/8	41/4	
2	75/8	101/16	45%	53/4	311/16	47/32	12	141/2	75%	9	43%	5%	
3	101/4	125/8	61/4	71/4	57/6	57/16	16%	191/2	10%	11%	7	611	
4	111/16	161/4	75/16	123/4	61/4	615/16	22	26%	11%	143/16	8	713	
5	1413/16	.20	9	161/8	61/2	83/4	323/16	411/2	173/16	19%	91/8	13%	

ALLEN-BRADLEY

Member of NEMA

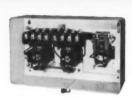
QUALITY MOTOR CONTROL

Your A-B Handy Catalog Lists These **Control Devices** Often Considered "Special"



BULLETIN 840 Float Switches

These quality switches are available in a wide range of types for automatic control of motors operating tank or sump pumps. The snap-action switch mechanism assures positive operation, no matter how slowly the liquid level changes.



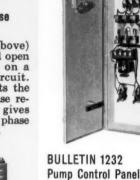
BULLETIN 1270 Automatic Transfer Switches

These switches are designed to transfer powerload to standby supply when normal power fails or drops too low. Auto-matically returns load to normal supply when power is resumed. Mechanically interlocked.



BULLETIN 812 Phase Failure-Phase Reversal Relays

Style F relay (above) protects against all open phase conditions on a branch motor circuit. Style R disconnects the motor upon a phase reversal. Style RF gives phase failure and phase reversal protection.



Pump Control Panels

Complete units for automatic operation of irrigation and oil well pumps. Employ stand-ard A-B Bulletin 709 magnetic starter with manual disconnect switch or circuit breaker in weatherproof enclosure. Wide variety of optional features available.



BULLETIN 555 Speed Regulators

Provide manual speed control of wound rotor motors for either fan or machine duty. When used with magnetic starter, the first step closes control circuit.



BULLETIN 805 Foot Switches

Ruggedly built to withstand the most severe industrial usage. Snap-action switch mechanism features maintenance free silver contacts. The foot switch shown above assures complete "safety" for the opera-tor. Also made without top guard.



BULLETIN 836 Pressure Controls

For machine tool hydraulic systems operating at pressures up to 5000 psi. Oiltight enclo-sure. Operating pressure and differential are adjustable. A visible indicator shows trip point. Maintenance free silver contacts.



BULLETIN 803 Rotating Cam Limit Switches

Heavy-duty controls for use on automatic production machines. Made with up to 12 independent circuits which can be separately adjusted for operation at any point of rotation.



BULLETIN 365 Multi-Speed **Drum Switches**

Designed for manual starting, speed changing, and reversing of polyphase multi-speed motors. Made for up to four speeds either non-reversing or reversing.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

OUALITY MOTOR CONTROL

Some Ideas



for your file of practical information on drafting and reproduction from

- KEUFFEL & ESSER CO .--

Anything you can do with a drafting machine you can do almost as well with a T-square, triangle and protractor. It just takes a *lot* longer and it's a *lot* harder. That's why so few drawing boards these days are seen "sans-machine."

Every board — and draftsman behind it — has slightly different requirements. This is why there are Paragon® Drafting Machines by K&E in a variety of tested styles. Just take your pick:

Whatever your angle ...

Taking a page out of school . . .

A lot of firms employ chalkboards for group work, demonstration, rough planning, and other forms of "communal" drafting activity. If you've got such a board around your shop, we've got just the machine to fit it. Called the "Chalkboard" AUTO-FLOW this is essentially an AUTO-FLOW with elongated horizontal and vertical tracks and special mounting brackets. Whatever the length or height of your chalkboard, there's a Chalkboard AUTO-FLOW to accommodate it.

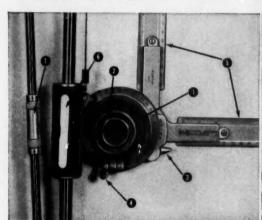
instantly, too. A convenient release lets you establish a new baseline in seconds, while maintaining your "0" setting on the protractor. And the Paragon standard has essentially the same engineered control head that so many swear by on the Paragon Auto-Flow — the biggest time-saver in drafting since paper.

For the sometime user...

Maybe you're a design engineer, a chief draftsman, an ex-draftsman "keeping his hand in," or any one of many having only occasional need for a drafting machine. If so, the Paragon Jr. (shown below) is your mate. Originally designed for desk use by students, the PARAGON Jr. is ideal for the "part-time" draftsman. Patterned after the PARAGON standard, this compact drafting machine offers all the important features found in its full-sized counterpart, plus the convenience of "tuck-away" dimensions. Its combination mounting bracket permits temporary or permanent mounting on almost any desk, board, or table. It will operate efficiently at any board angle up to 25° and will accept any scales with standard chuck plates. Its engineered control head has full 360° indexing with automatic 15° stops, a convenient lock-lever for intermediate settings, and a rapid release for full 360° base-line adjustment while retaining "0" indexing.



And that's the lot—a Paragon, we hope, for everyone. If the ease and speed of "feather-touch" drafting has a place in your operation, simply fill out and mail the coupon below and we'll show you how the Paragon of your choice delivers it—like no other drafting machine can.





1. Full 360° indexing with automatic 15° stops, released at a touch, 2. Conteur-designed control knob to match shape and motions of the hand, 3. Thumb-release to set in-between angles, 4. Baseline release — located near protractor head for fastest operation, 5. Easily-adjusted, interchangeable scales, 6. Conveniently placed finger-tip brake control to lock or release vertical position, 7. Convenient horizontal motion brake for one-hand operation, sitting or standing.

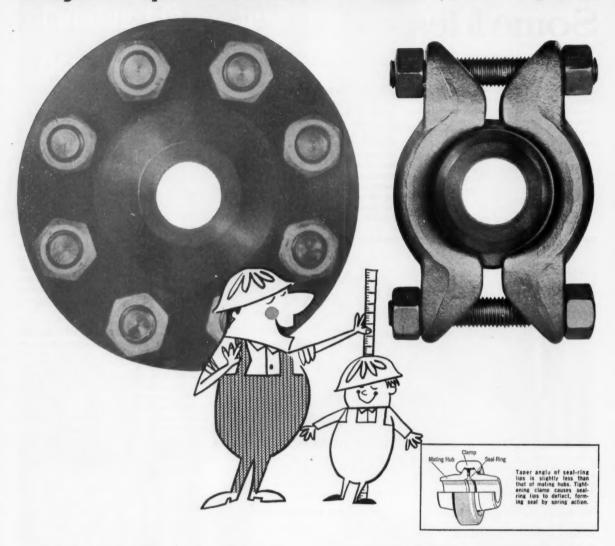
The Paragon Auto-Flow® Drafting Machine is tops-by far the most versatile drafting machine to come along in years. A track-type machine with a wealth of work-saving features, the Auto-Flow can simplify your whole drafting operation. The board angle you find most convenient will suit the Auto-Flow to a "T." And no irksome counterbalance weights or friction brakes are necessary. A quick adjustment of a tension spring wheel puts the Auto-FLow in perfect balance - vertically, or anywhere down to the horizontal. The AUTO-FLOW's scales can be moved quickly and locked firmly into any position on the board. Both horizontal and vertical motion brakes are designed for rapid, one-hand operation. Smooth, full-board action lets you draw straight lines the entire length and width of the board in one continuous motion - something it's impossible to do with conventional machines. And - the piece de resistance - the Auto-Flow's superbly functional designs puts all controls conveniently on, or adjacent to the control head for the easiest operation ever. This engineered control system considerably reduces the number of arm and hand motions needed to produce a finished drawing.

An old dog with new tricks...

If you prefer the conventional, "elbowarmed" drafting machine, the PARAGON standard is just your dish. You'll find plenty of refinements here, too. This is one "elbow-armed" machine that won't creep or crawl on the board. Just a twist of a thumb screw adjusts for perfect arm balance at any board angle up to 10°. The arms themselves never need adjusting. Tension bands are factory-set for years of use. Scales always lie snug and flat on the board and both arms twist freely in either direction. They can be lifted over objects on the board and returned to the same setting with ease. Baselines can be changed

indicated:	 Paragon Drafting Machine(s)			
mulcateu.				
C K&E PARAGON AUTO-FLOW Drafting Machine	K&E PARAGON standard Drafting Machine			
☐ K&E PARAGON Chalkboard Auto-Flow Drafting Machine	K&E PARAGON Jr. Drafting Machine			
Name & Address:				

Grayloc Pipe Connections Save 1/3 the Space



GRAYLOC® pipe connections are up to one-third smaller than flanged connections with comparable maximum pressure ratings. They save wasted space—cut unit weight and assembly time drastically.

An all steel assembly, GRAYLOC employs a pressure aided seal that can be assembled or disconnected in minutes. The heart of the assembly—the seal ring—is completely reusable.

Although GRAYLOC connections are manufactured in standard stock sizes from 1" to 30", special sizes for special applications are available on request. Corrosion resistant metals can be provided on short notice.

You can use GRAYLOC connections in your piping system. They'll save you maintenance and assembly time, space and money. To learn how, write for the new GRAYLOC catalog.



P.O. BOX 2291 . HOUSTON 1, TEXAS . RIverside 7-1240

for fast, accurate on-the-job sketches,

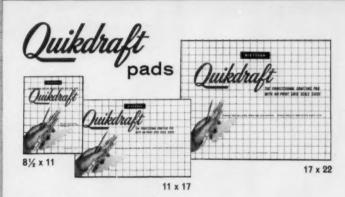
DIETZGEN

uikdraft DRAW IT WITH

Now you can create dimensionally accurate "freehand" sketches anywhere, anytime with Quikdraft . . . the new professional drafting pad. Quikdraft features Dietzgen's famous drafting vellum printed with an accurately centered "no-print" grid. The grid appears as light blue lines and serves as a convenient scale guide in creating all types of architectural and engineering drawings. But because the grid will not reproduce, prints from your Quikdraft sketch show only the pencil drawn lines and lettering. Now with the aid of a straight edge, your free-hand sketches become finished detail drawings saving hours of tedious boardtime re-drawing rough

Available in three standard sizes and your choice of 4x4, 8x8 and 10x10 squares to the inch grids, Quikdraft pads are stocked by your nearby Dietzgen Dealer. He is listed in the yellow pages under "Drafting Equipment & Supplies" . . . see him today. EUGENE DIETZGEN CO., Chicago 14, Illinois.

Circle 252 on Page 19



"no-print" grid scale guides... 8 x 8

Double flap construction provides 4-corner protection . . . no soiled or dog-earred corners. Under-flap provides a firm, smooth drawing surface. Dietzgen Redi-reference conversion tables are a bonus feature with every Quikdraft pad. Saves time, saves errors when making calculations on the job.



Extra-heavy back gives Quikdraft pads extra support . . . it's like having a portable drafting board on the job.





Smaller! About 20% smaller than Size 0 Starters. Just 5 3 /4" wide, 7" high and 4 3/16" deep.



Convertible Carried in stock with three cover options or easily con-verted in field from treset" only to "start and stop-reset or three-position selector switch." Kits at optional cost.









Size 00 Size 0



Size 2



Size 3



Size 1

Size 4



A new addition to the famous three star line

New! Save space and money with Cutler-Hammer's Size 00 A-C Magnetic Starter

Takes up to 20% less space...costs 18% less than Size O Starters. Now you get two big new bonuses in control selection...less space and less money Both with the all new Size 00 Starter.

Before, you had to use a larger starter in applications where it really wasn't needed. But, now you can use the Size 00 in about 40% of the applications where the Size 0 is

usually used.

The new Cutler-Hammer Size 00 Starter performs to the same high standards you get from all Cutler-Hammer Starters. And, you still get vertical, dust-free contacts which add so much to more reliable starter performance. Your choice too, of 2-coil or 3-coil overload

protection in the same small enclosure.

The Bulletin 9586 Size 00 Starter can be used on any general application. Its maximum horsepower ratings: Three phase: 208/220 volts, 1½ hp. 440/550 volts, 2 hp. Single phase: 115 volts, ¼ hp. 230 volts, 1 hp. It's available open or in NEMA 1 enclosure. Send for Pub. LO-40-M243.

Why you get more from Cutler-Hammer. New things are happening at Cutler-Hammer—new, better products, new engineering ideas and talent, new plant capacity. We're on the move. And, we'd like to show you how we could help you in any electrical control problem. Contact the nearest Cutler-Hammer distributor.

WHAT'S NEW? ASK ...

CUTLER-HAMMER

Cutter-Hammer Inc., Milwaukee, Wisconsin - Division: Airborne Instruments Laboratory - Subsidiary: Cutter Hammer International, C. A. Associates: Canadian Cutter-Hammer, Ltd.; Cutter-Hammer Mexicana, S. A.



GASKET GAUGE vs. TORQUE RETENTION

Gasket thickness is one of several factors affecting retention of initial torque loads. New study indicates significance of minor variations in gauge.

E. M. SMOLEY Research Physicist Armstrong Research and Development Center

Significant variations in the torque retention of a gasket material result from relatively small changes in thickness. This is one of the conclusions of a general study of the torque-retention problem made at the Armstrong Research and Development Center.

Generally, this work confirmed the widely accepted idea that maximum torque retention is usually obtained by using the thinnest gasket possible. But In the test, each different gauge of the material was bolted between steel flanges, and the assemblies were placed in an oven at 300° F, for 18 hours.

Torque was then re-measured while the flanges were still hot. The thinnest gasket (1/64'') showed an exceptionally low torque loss of only $\frac{1}{2}$ of 1%.

The torque loss rose to 39% for the 1/32'' gauge. The loss for the 1/16'' material was 68.5%.

lowers cost and minimizes extrusion problems.

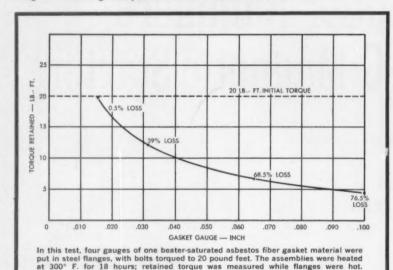
However, Armstrong engineers point out that there are mechanical factors that limit gauge reduction beyond a certain point. One is that, to provide a seal, gaskets must be compressed more than the cumulative deviation from perfect parallelism of the two flange surfaces.

For example, take a 1/32" gasket cut from a material capable of a 50% compression. If used where the cumulative inaccuracies of the flanges are more than 1/64", leaks will result. The alternatives are to use a thicker gasket, or a more compressible material.

Sheet metal or other lightweight flanges that permit bowing between bolts also work against the use of thin gauge gaskets. The bowing can sometimes be compensated by using a thicker gasket or a more compressible material. A more desirable alternative is to build more rigidity into the flange.

Gasket thickness is only one of many factors in gasket engineering that are under continuous study at the Armstrong Research and Development Center.

In the course of this work, we have built up a large library of data on gasket engineering. If you have a problem involving gasket design, selection, or performance, we may already have the answer. We will be glad to make suggestions if you will submit details to us. Write to Armstrong Cork Company, Industrial Division, 7106 Dean Street, Lancaster, Pa.

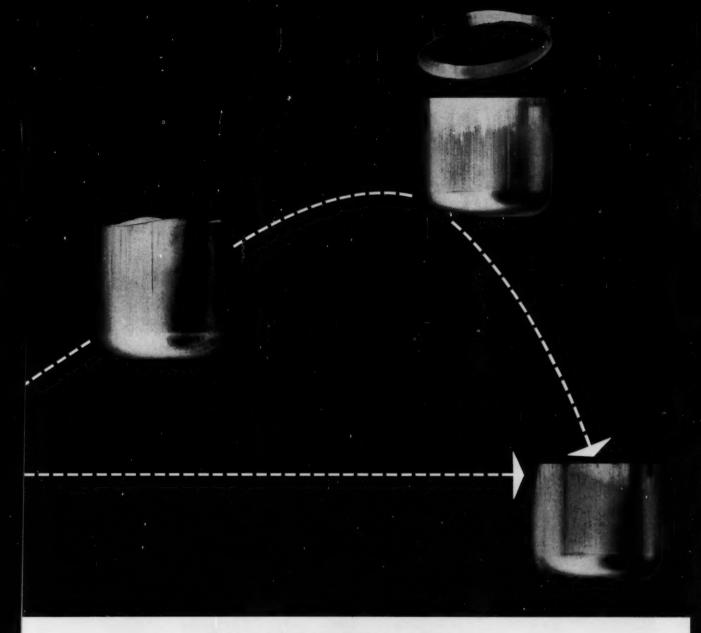


the magnitude of variation produced by changes in gauge was greater than had previously been estimated.

One phase of the study is charted above. In this curve, retained torque is plotted along the vertical scale, and uncompressed gasket thickness is indicated along the horizontal scale. The initial bolt torque was 20 pound feet for each of the gauges tested. It is estimated that bolts at least 5" long would be required to eliminate most of the torque loss (76.5%) on the 1/10" material. Actually, 1" bolts were used in all these determinations.

In addition to these mechanical advantages, the use of thin gaskets also

Armstrong GASKET MATERIALS



ARE YOU TAKING THIS COSTLY PRODUCTION "DETOUR"?

The problem is a common one in steel drawing operations: How to eliminate scalloping or "ears"?

One way is to trim them. The other is to eliminate them—at the purchasing stage.

You can do this by specifying J&L Precision Non-Scalloping cold rolled strip steel. Through precise control of every production step, J&L has developed a low carbon strip which is non-scalloping.

Result: a major operation—trimming—can be saved. Also, you'll have fewer rejects and less down-time. These advantages mean more profitable production—and are especially important in operations involving progressive dies, where uniformity and protection of equipment are major factors.



Non-scalloping strip is just one of the full line of precision products backed by J&L's combination of specialized equipment and techniques, plus experience. For information, call your J&L Stainless and Strip Division representative or write to Dept. 1360.



LOW CARBON . HIGH CARBON . ALLOY . STAINLESS TEMPERED SPRING STEEL . ZINC AND COPPER COATED

Circle 254 on Page 19

Another finishing first from Amchem!

ALODINE* Chemicals for Spray-Dip Processing Costs in Half Through and Handling at Crown Aluminum!



Crown aluminum siding features beauty, durability and convenience... a wide selection of color harmonized paints, year-in, year-out product performance and virtually no maintenance. Amchem Alodine plays a key role in providing the paint system with its outstanding wearing qualities.

Pre-Paint Finishing Slashes Reduced Maintenance, Downtime



Mr. LOUIS HIRSCH, dynamic Crown President says -

"THE INDUSTRY'S FIRST ORIGINAL DESIGN SPRAY-DIP SYSTEM HAS LOWERED THE COST OF SIDING PROCESSING WHILE MAINTAINING HIGH QUALITY AND UNIFORMITY"

Inspired and designed by Amchem in conjunction with Crown engineers and quality control personnel, the industry's first spray-dip, pre-paint system designed from the ground up, is providing Crown Aluminum—one of the nation's top three siding producers, with unprecedented savings in processing costs, time and labor.

On several million square feet of aluminum strip treated to date, Crown can point to a 50 percent reduction in overall processing costs through virtual elimination of costly maintenance and downtime. With the addition of this new line, siding production capacity has doubled.

In side-by-side comparisons with an existing all-spray system at Crown's Roxboro (N. C.) plant, the new spraydip combination has demonstrated outstanding superiority over straight spray—the result of eliminating complicated, time-consuming periodic maintenance associated with spray chamber operation.

Under all of Crown's exacting test standards—salt spray, humidity, infra-red—Alodine quality has remained constant. The proof—not a single paint failure complaint from the field since production started!

If you're considering installation of pre-finishing equipment, or refurbishing your present system—don't make a move till you've investigated Amchem Alodine and spray-dip for coated coil processing. Your nearest Amchem Representative is ready to supply facts and figures on system requirements at your convenience.

* Amchem's registered trademark for its conversion coating chemicals for aluminum.



Crown 5-stage Amchem spray-dip line located on mezzanine level of plant. Overall length of finishing and paint line is 291'6".



Amchem electronic sensing device on stage one cleaner provides automated feed of chemicals.



Amchem Technical Representative conferring with Crown Production Supt. George Hagler (left) on final adjustments to new paint line.



ALODINE

Amchem is a registered trademark of

AMCHEM PRODUCTS, INC. (Formerly American Chemical Paint Co.)

AMBLER, PA. • St. Joseph, Mo. • Detroit, Mich. • Niles, Calif. • Windsor, Ont.



Write for Bulletin 1424C, gives detailed technical specifications on different Alodine chemicals available for pre-treating aluminum.

HIGH-SPEED SWITCHING



Check these

Mercury-Wetted Relays against your design needs

Choice of two basic switches

SPEED TO 200 CPS



This CLARE TYPE HGS is the fastest operating, most sensitive mercurywetted contact relay obtainable. It will operate at speeds to 200 cps with sensitivity as low as 2.5 milliwatts with a contact rating of 2 amperes, 500 volts (100va max.). Two permanent magnets provide single-side stable and bi-stable adjustments. Available with Form D (bridging) contacts.

LOADS TO 250 VA



This CLARE HG capsule will handle contact loads as high as 5 amperes, 500 volts (250va max.). Operating time may be as low as 3 milliseconds. It is also available equipped with two permanent magnets (HGP TYPE) for single-side stable, bi-stable or chopper operation.

The Clare **Mercury-Wetted** Relay Principle

The remarkably long life of CLARE mercury-wetted relays is the result of a design principle whereby a film of mercury on the contacts is constantly renewed, by capillary action, from a mercury pool. Both CLARE HGS and HG switch capsules employ this principle. Both switches are sealed in high-pressure hydrogen atmosphere. Certain construction differences, however, give greater speed and sensitivity to the HGS switch.

FOR BILLIONS OF OPERATIONS

Choice of three convenient packages

ENCLOSED MODULES



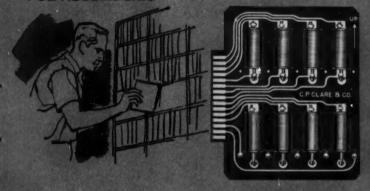
Both CLARE HGS and HG switch capsules are available in steel-enclosed modules for convenient mounting on printed circuit boards in the same manner as resistors, capacitors and similar components. The enclosure is ruggedly designed and provides both excellent mechanical protection and magnetic shielding. These modules are ideal for design and prototype work.

CONVENTIONAL PLUG-IN RELAYS



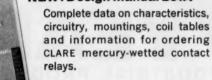
CLARE HGS switch capsules are available in single switch units, surrounded by a coil, mounted in high-melting point wax and encased in cylindrical stoel containers provided with plug-in base. A smaller type (HGSS) is designed for use where space is limited. HG relays are available with one, two, three, or four capsules, surrounded by a single coil. Also with permanent magnets (HGP) for single-side stable, bi-stable or chopper operation.

PCB ASSEMBLIES



Printed circuit board assemblies are available with either HGS or HG switch capsules to meet design specifications. These may be designed to customer specifications by CLARE or mounted on boards supplied by the customer. Number of relays is limited only by the dimensions of the printed circuit board.





See your nearest CLARE representative or address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ontario. Cable Address: CLARELAY.

C. P. CLARE & CO.

Relays and related control components

Circle 256 on Page 19



EXCLUSIVE! GOODYEAR GREEN SEAL V-BELTS

to give you sets that are precision-matched in length to outperform...and outlast...all others

At no extra cost, GREEN SEAL V-Belts also give you:

Dimensional stability throughout the life of the belts via highly shrink- and stretch-resistant 3-T Process Cord or airplane-type steel cable.

Protection against dampness through special mildew-inhibited rubber compounds.

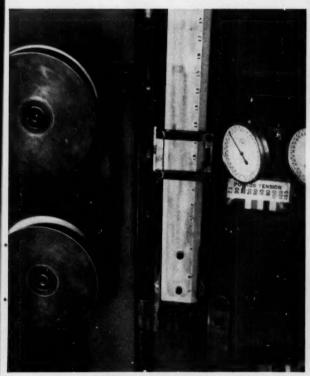
The most complete line of V-Belts in the industry—easily and quickly available through our nationwide network of distributors. Still another "plus": The G.T.M.—Goodyear Technical Man—is available to help you select the right belts for any drive.

For your best buy in multiple drive belts—including new money- and space-saving HY-T Wedge V-Belts—look to Goodyear. Also, get the full story on P.D. (positive drive) Belts and Variable Speed Belts from your Goodyear Distributor. Or write Goodyear, Industrial Products Division, Akron 16, Ohio.

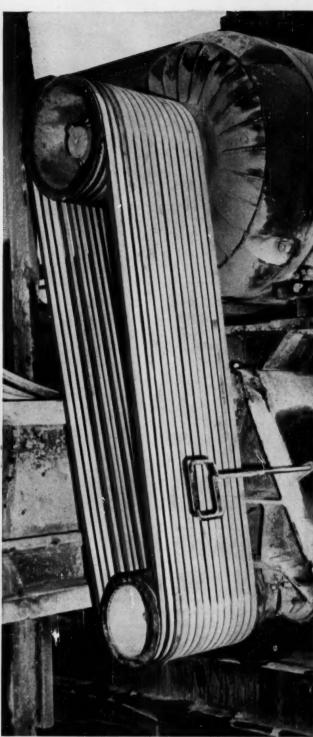




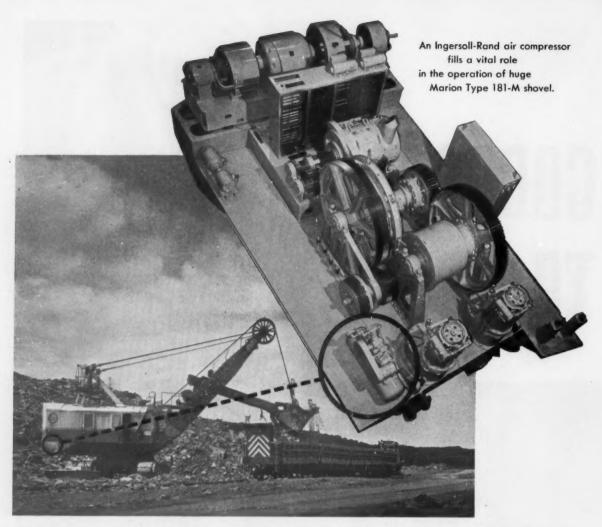
CODES TO 1/32"...



Length-coding GREEN SEAL V-Belts to 1/32" not just 1/10" like most belts—takes this ultraprecision machine. Only Goodyear has this type of equipment, which is set by means of finetolerance steel templates to insure accuracy.



Harnessing this big, 22-saw stonecutter for 3 full years required COMPASS-V-Steel Belts by Goodyear. Over this period, the Goodyear belts helped carve up 20 tons of rock a day—over 15,000 tons in all. Normal V-belt life in this type of rugged service is a scant 6 months.



design with Ingersoll-Rand for dependability



Equipment designers and product engineers can match their most rigid specifications from this complete line of Ingersoll-Rand air-cooled air compressors. Top efficiency and operational economy plus important savings in space and weight make I-R compressors the top choice for dependable components.

Ingersoll-Rand air-cooled air compressors are available as bare units, baseplate mounted or tank mounted in sizes ½ through 20 hp. In addition, I-R can furnish high pressure compressors, non-lubricated compressors and vacuum pumps.

Ingersoll-Rand

LI'L ABNER by Gel Copp







Here's proof that USS Galvanized Steel USS Galvanized Sheets make excellent ductand bend, and the zinc coating won't flake off. stay tighter. Installation is quick and easy. drawing characteristics of the metal.



This "container" of USS Galvanized Steel Sheets have exceptional workability-twist work. They're strong and rigid. Lock joints illustrates the outstanding formability and

United States Steel Corporation • Columbia-Geneva Steel Division Tennessee Coal & Iron Division • American Steel and Wire Division United States Steel Supply Division • United States Steel Export Company.

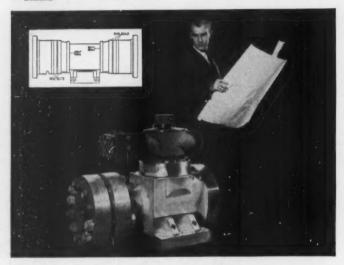


United States Steel



THE RAW MATERIALS OF PROGRESS

No part too large or complex for corrosion protection with KEL-F® Dispersion coating



The five-ton valve above is used to test a rocket engine fuel line. Its flow valve meters a highly corrosive mix—liquid oxygen and kerosene fuels—at temperatures below —300°F. and pressures up to 5,000 lbs. psi. Yet valve leakage in this precision assembly is zero. And the designer credits corrosion-blocking KEL-F Brand Dispersion coating on valve seat rings and seals, at eight critical points (see diagram above).

Parts and surfaces too large

or intricate to fabricate from a molded plastic can have the benefits of halofluorocarbon protection with KEL-F Dispersion. First you spread, spray or dip coat it. Then with heat application KEL-F coating fuses into a tough, adherent, continuous coating with extreme resistance to corrosive chemical attack at a wide temperature range. (See "profile," right). For further information and design data, fill out coupon below . . .

3M Chemical Division, Dept. KCG-61 3M Company	TELL ME MORE
St. Paul 6, Minn.	about KEL-F Dispersion coating
Name	
Title	
Company	
Address	
City & State	

PROPERTIES PROFILE

ON

KEL-F Dispersion coatings

KEL-F Dispersions were developed to extend the protection of KEL-F Plastic to the surfaces of parts that do not lend themselves to fabrication from molded plastics because of size, design or construction. Consisting of fine particles of KEL-F Plastic suspended in a volatile organic liquid, KEL-F Dispersions can be applied to many metallic and certain non-metallic surfaces by spray, spread or dip coating. Heat fuses the dispersion into a tough, permanent protective coating with high tensile and compressive strength, good elongation, and excellent abrasion and wear resistance.

TYPES OF DISPERSIONS	Type KF-625	Type KF-502 Spread, flow, dip 3.4	
Application Method	Spray		
Pounds solids per gallon	3.6		
Approximate square foot coverage per gallon (per mil thickness)	295	330	
Viscosity, Zahn G-1 Cup, 75°F. secs.	34	-	
Viscosity, Brookfield, 75°F, cps.	-	9-10,000	
Thinners	Xylene	Amyl Acetate	

PROPERTIES

Chemical resistance. KEL-F Dispersion coatings resist attack by strong acids, alkalies, gases and oxidants and extremely high temperatures. This makes them outstanding corrosion protectors for aerospace equipment.

Anti-stick characteristics. Glues, inks, paints, greases, waxes, rubber or casting resins will not readily adhere to coatings of KEL-F Dispersions. Coating surfaces of aerospace equipment with KEL-F Dispersions reduces clean-out and shutdown time.

Temperature resistance. Temperature-resistant KEL-F Dispersion coatings have an operational range of 710°F. (—320°F. to +390°F.).

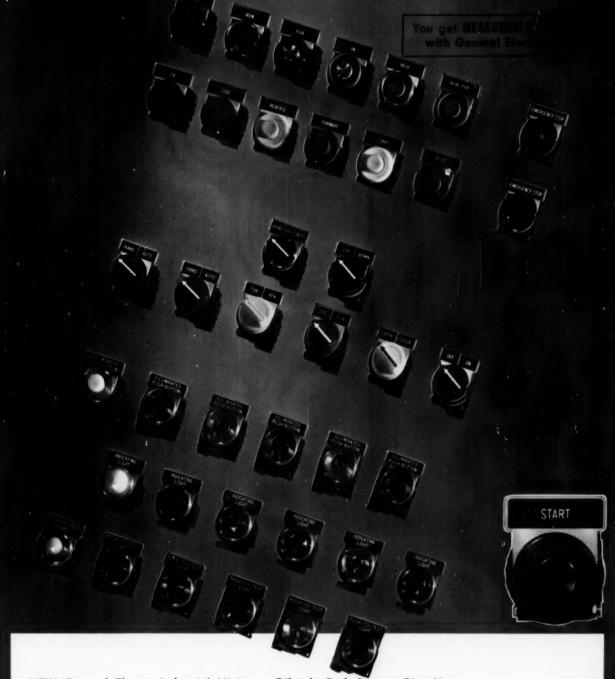
Dielectric strength. KEL-F Dispersion coatings have high dielectric strength at low to very high operational frequencies and temperatures. Nonwetting surfaces permit no moisture absorption, minimize flashover.

For full information on KEL-F Halofluorocarbon Dispersion coating systems, send for our brochure on the subject, or write, describing your area of interest to 3M, Chemical Division, Department KCG-61, St. Paul 6, Minnesota.

MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW





NEW General Electric Industrial Miniature Oil-tight Push Buttons Give You . . .

COLORS UNLIMITED, OVER 40% SPACE SAVINGS

Now you can reduce the size of your control panels at least 40 percent. New General Electric miniature oil-tight push buttons require only about half the panel space of heavyduty oil-tight units.

Improve machine appearance. Unlimited color combinations are available in operators and rings to complement your equipment—provide positive color identification from any angle. Color is permanent; won't wear off, chip or fade.

Industry's first full line allows you to design entire panels with miniature units. Choose combinations of: standard (with or without guard) and mushroom-head push buttons; wobble stick operator; maintained and spring-return selector switches; coin-operated, cylinder-lock and bat-lever

selector switches; resistor and transformer-type illuminated push buttons, indicating lights, and push-to-test lights. G-E miniature push buttons are available in complete units or as separate components, to allow you to make up any form you need with a minimum stock.

Call your General Electric sales engineer or distributor today, or write for publication GEA-7127, General Electric Co., Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL 🥞 ELEC







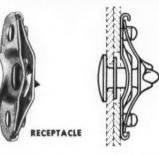
For quick access and closure...

LION 1/4 TURN OPEN FASTENERS











Hinged and completely removable panels are secured reliably by unique Lion Fasteners which are opened or closed by a quick 1/4 turn. These mil spec (MIL-F 5591A-ASG) fasteners have a high strength to weight ratio, lock smoothly with a positive grip, withstand vibration.

ALIGNMENT NOT CRITICAL

Both stud and receptacle "float" to accommodate misalignment. The hole, which retains the stud, is twice as large as the stud cross-section. This permits a float of .070 in all directions. The leaf spring receptacle also floats to accommodate stud positions.



WIDE VARIATIONS IN STACK HEIGHT

Total sheet thickness may vary as much as +.035 or -.015 without affecting operation. A Lion stud, specified for .160 total thickness, for example, will accommodate any stack height between .195 and .145.

SWAGED-NOSE STUD

Extra strength and smooth operation are made possible by the swaged-nose design. All the metal in the stud goes to work. There are no thin crosspins, holes or milled slots to weaken the cross-section. Case hardening is further assurance of long, trouble-free

WIDE VARIETY

Lion Fasteners are available in 3 sizes

No. 5, No. 2, and Miniature. An assortment of head styles is supplied -oval, flush, wing, ring, notched or knurled-according to individual requirements.





Send for your free copy of Southco Fastener Handbook No.11. Gives complete engineering data on Lion Fasteners and other special fast-eners. Write to Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pennsylvania.



















Dow Corning

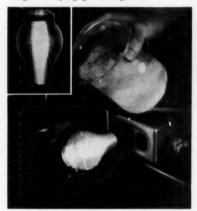
SILICONE NEWS

for design and development engineers . No. 83

SHATTERPROOFED WITH SILICONES

One of the most common safety hazards
— exploding light bulbs — has been
overcome in a new incandescent lamp
through the use of silicone adhesives
and glass yarns.

Developed and marketed by Duro-Test Corporation, North Bergen, New Jersey, the new lamp—named "Flamescent"—is truly shatterproof. It can be dropped onto a hard surface without exploding into a shower of glass. While in use (and hot) it can be dipped in ice water without danger of flying glass fragments.



Unique application of new and old materials gives the lamp this safety-glass ruggedness. The bulb consists of a glass shape wound with (Cont. pg. 2)



New Finish For Hot Spots

Metal products of all descriptions can now be made to stay new looking longer even when subjected to hot operating temperatures or to the deteriorating effects of weathering. How?-By using protective coatings and finishes formulated with Dow Corning silicone resins.

Colored product finishes based on these semi-inorganic resins won't crack or blister 600 F. Gloss and color are retained even though constantly exposed to sunlight or corrosive atmospheres. Result — longer life, and increased customer satisfaction.

New silicone-alkyd baking enamels combine ease of application with flexibility and toughness. Using these enamels, it's frequently practical to paint-before-forming metal parts. Baking cycles are consistent with standard painting practices.

Full range of colors, too. Silicone-based paints can be pigmented almost any hue.

Available now from many paint manufacturers, silicone-based paints could help make important changes in your quality and profit picture. For more information and names of suppliers, circle . . No. 242

Paint based on new Dow Corning resintakes a 180° bend on a 1/4" mandrel without crazing, checking, or peeling.



Reproduces Fine Detail

The making of what are believed to be the most accurate models of the moon in existence today was given a big boost by Silastic® RTV, the fluid silicone rubber that cures at room temperature.

By pouring Silastic RTV over his original, painstakingly constructed model, Mr. William Benton, "the moon man", obtained flexible and dimensionally stable molds that perfectly duplicate the extremely fine details of the original. Polyester resins are cast in the RTV molds to make more of these accurate moon models.

Silastic RTV is easy to use. Simply mix it with a catalyst and pour. The mix flows freely, filling every hairline. After a few



Reproduction: Benton model of the moon

hours at room temperature, you have a flexible silicone rubber mold that strips readily. You're ready to start casting!

Flexible molds for producing prototype parts in plaster, plastics, waxes or low melt alloys are quick and inexpensive with Silastic RTV. Circle No. 241

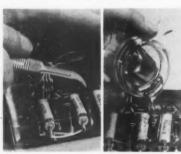
Dow Corning SILICONE NEWS Page 2





WANTED: CREATIVE ENGINEERS

... to investigate a unique new silicone resin that cures to form a tough, transparent mass. Named Sylgard® 182, this new solventless silicone resin is supplied as an almost colorless liquid. After blending with its curing agent, it's a simple matter to pour it in place.



Even in totally confined enclosures, Sylgard 182 cures to a flexible and transparent material having outstanding dielectric properties and good moisture resistance from —100 to 400 F. On the Shore A Scale, hardness of Sylgard 182 is approx-

imately 40; elongation is in the range of 100%. Tensile strength is in the range of 800 to 1000 psi.

Curing time for Sylgard 182 Resin can be varied by changing the curing temperature. At 150 C, it cures in 15 minutes; at 65 C, four hours; at 25 C, three days. Neither the resin nor its curing agent is toxic to the skin. No toxic fumes are given off during mixing or curing.

Electronic components and circuits encapsulated in Sylgard 182 Resin are clearly visible, simplifying replacement or repair procedures. The cured resin can be cut away with a sharp knife to permit repair or replacement of defective components. New resin poured over the repaired area adheres to the existing cured material, restoring the encapsulant to the original condition.

Keep in mind that while this new material exhibits some rubber-like properties, it is a solventless silicone resin, not a rubber. For more data and information about Sylgard 182, circle No. 243

new literature on silicones

Silicones in Appliances can give that extra edge for extra sales. This colorful booklet tells where and how silicones are being designed into appliances to give more efficient and reliable performance. Illustrations show how planning around silicones can make good products better. No. 245

Space Age Silicones are described in thirty typical application stories. Utilization of silicone compounds, fluids, lubricants, protective coatings, rubbers, resins, potting materials and sealants are illustrated for your consideration. This valuable brochure offers solutions to many problems encountered in designing space age aircraft and ground support equipment.

No. 246

LIGHT BULB (Continued)

Fiberglas yarn. The glass and yarn are bonded into a single unit with a rubbery Dow Corning silicone adhesive. Several materials were tested but only the silicone adhesive remained transparent and resilient despite long, continuous exposure to the heat of the lamp.

While the Flamescent derives its name from the warm, flame-like glow it casts, its lumen output is actually higher than that of any other processed bulb. It is a glareless bulb and lasts at least 3 times longer than conventional lamps...

Available in standard sizes, the Flamescent with its weatherproof features is ideal for yard and outside display lighting. Duro-Test also recommends the new bulb for use in all types of industrial and commercial fixtures where the bulb may come in contact with flying sparks, welding slag, hot solder, water, and many other attacking conditions.

 Dow
 Corporation
 Doyt
 6818
 Midland
 Midland
 Michigan

 Please send me:
 241
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TITLE COMPANY

STREET _____ZONE__STATE___

SILICONE NEWS is published for design and development engineers by

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Dow Corning CORPORATION

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE IN COUPON ABOVE,
OR REFERENCE NUMBER ON READER SERVICE CARD

TURBINES:

Shell reveals three ways that Turbo Oils help prevent oil breakdown, rust, sludge and foaming

Small quantities of air and water can work their way into any turbine lubrication system. These contaminants can accelerate oxidation of the oil.

Read how Shell scientists developed a specific formulation that counters this oxidation and brings you turbine lubricating oils with top performance records.

When oxygen attacks turbine oil, it can form peroxides and organic acids. A chain of oxidation reactions begins. If the oil stability is inadequate, sludge can form.

Air entrained in the oil can aggravate oxidation. And it may cause foaming.

The oil may also be affected by water in the system. Laboratory tests have shown that water can greatly accelerate an oxidation process.

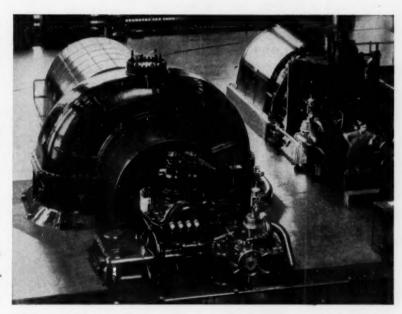
With Shell Turbo® Oil, Shell tackles these problems in three key ways:

1. Shell carefully selects base oils for use as turbine lubricants, then refines them to get the most effective response to Shell's special additives.

2. Shell adds a powerful oxidation inhibitor to its precisely refined base oils. This inhibitor helps prevent the chain of oxidation reactions caused by oxygen exposure at operating temperatures. It helps keep the oil in good condition, and lengthens its service life.

The result is that Shell Turbo Oils have proved themselves unusually stable over long service periods.

3. Shell uses an outstanding rust inhibitor. As a protective measure, Shell uses special additives that cover metal-



Shell Turbo Oils lubricate turbines with total rating of more than 17 million kw in the U. S. and Canada.

lic surfaces with strongly adherent polar-type films.

These films are designed to help keep water from the metal surface.

A message to manufacturers of turbine equipment

There are several grades of Shell Turbo Oil. One of them suits your equipment.

1. Your customers can get Shell Turbo Oils at Shell depots everywhere. Readily available throughout the world.

2. Quality is consistently high. Shell Turbo Oils always deliver top performance.

In drastically accelerated laboratory tests, metals immersed in Shell Turbo

Oils show outstanding anti-rust performance—even in the presence of sea water.

Ask your Shell Industrial Products Representative for facts on Shell Turbo Oils. Or write: Shell Oil Company, 50 West 50th Street, New York 20, New York.



A BULLETIN FROM SHELL

-where 1,997 scientists are working to provide better products for industry

Post-Forming: New Way to Bigger Savings with Malleable Castings

The ductility of Malleable iron castings permits use of high-speed forming techniques to finish Malleable parts at lower cost. Take advantage of the versatility you get only with ferritic and pearlitic Malleable castings. For a fuller understanding of how Malleable can help you, call any producer that displays this symbol—

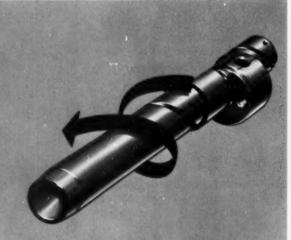


Free Folder describing these techniques is available for your use. Just ask any member of the Malleable Castings Council for Data Unit No. 116, or write to Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

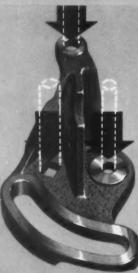




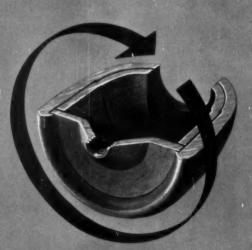
Hot Form It — Hot coining this Malleable transmission part reduces finished cost...eliminates three cutting operations required by the previously used steel part.



Roll It — Oil grooves in lawnmower crankshafts and splines in compressor crankshafts are just two of many places where rolling proves more economical than machining.



Punch It — Holes with diameters greater than the thickness of the metal can be punched in Malleable. Two round holes and a square hole are punched simultaneously in this idler arm.



Spin It — Malleable's ductility permits the sleeve and end disc in this ball joint to be held in place by spinning the Malleable housing into a strong, permanent flange.

Get the most for your metals dollar...get

MALLEABLE

CONNECTICUT
Connecticut Mail. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck

DELAWAREEastern Malleable Iron Co., Wilmington 99

Central Fdry. Div., Gen. Motors, Danville Chicago Malleable Castings Co., Chicago 43 Moline Iron Works, Moline Moline Malleable Iron Co., St. Charles National Mall. and Steel Castings Co., Cicero 50

Peoria Malleable Castings Co., Peoria 1 Wagner Castings Company, Decatur

INDIANA Albion Malleable Iron Company, Muncie Division, Muncie Link-Belt Company, Indianapolis 6

National Mall. & Steel Castings Co., Indianapolis 22

IOWA Iowa Malleable Iron Co., Fairfield MASSACHUSETTS Beicher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE Laconia Malleable Iron Co., Laconia

NEW YORK Acme Steel & Mall. Iron Works, Buffalo 7 Frazer & Jones Company Division Eastern Malleable Iron Co., Solvay Oriskany Malleable Iron Co., Urskany Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Central Fdry, Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div.,
Columbus 16
National Mall. and Steel Castings Co.,
Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Maileable Iron Co., Erie
Lancaster Maileable Castings Co., Lancaster
Lehigh Foundries Company, Easton

Meadville Maileable fron Co., Meadville Pennsylvania Malleable fron Corp., Lancaster

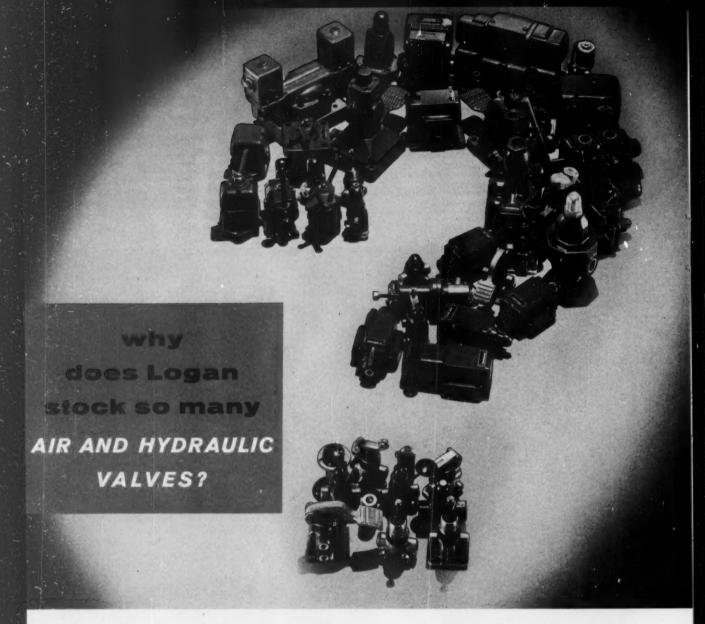
TEXAS Texas Foundries, Inc., Lufkin

WEST VIRGINIA West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc.,
West Allis 14

West Ams 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works,
Milwaukee 46





Logan offers a wide selection in size and design of both air and hydraulic valves to meet a demand that has steadily grown over the years.

This effort to be of service beyond the design and manufacture of air and hydraulic equipment has been a vital part of the Logan program since the company was founded.

_FACTS OF LIFE

_300-2 PRESSES

If you would like more information about valves, or other Logan products, merely fill in the coupon below.



Circle 265 on Page 19

Check the Items you want, fill in your name and address, tear out and mail to:

Logansport Machine Co	., Inc. • 710 Center Avenu	e, Logansport, Indiana
100-1 AIR CYLINDERS	200-1 HYD. POWER UNITS	Please send copy of catalog
100-2 MILL-TYPE AIR CYLS. 100-3 AIR-DRAULIC CYLS.	200-2 ROTOCAST HYD. CYLS. 200-3 750 SERIES HYD. CYLS.	NAME
100-4 AIR VALVES 100-5 LOGANSQUARE CYLS.	200-4 and 200-7 HYD. VALVES 200-6 SUPER-MATIC CYLS.	TITLE
100-6 ULTRAMATION CYLS. 100-7 SUB-PLATE AIR VALVE	ABC BOOKLETCIRCUIT RIDER	COMPANY
300-1 CHUCKS	CALCULATOR	ADDRESS.

Designing a machine?

Let your local
Gates Engineer
Prove Super HC
Drives save space,
weight, money

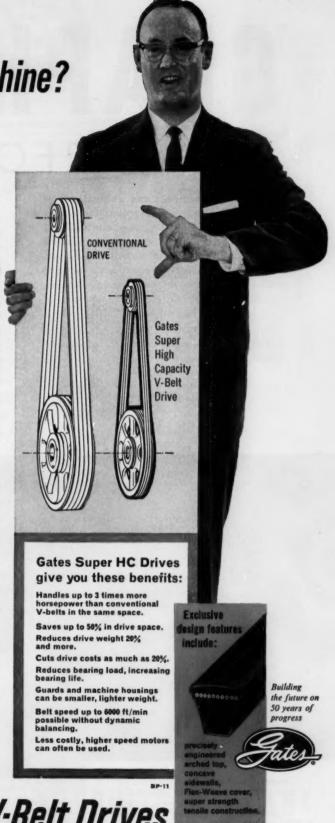
If you are designing a new machine or redesigning one for better performance, your local Gates Field Engineer will be glad to help you. He can show you how to take full advantage of the many opportunities offered by Gates Super HC High Capacity Drives.

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Manufacturers everywhere have standardized upon the Gates Super HC V-Belt Drive—industry's first and most advanced high capacity drive. It is your best assurance that your power transmission unit will not soon become obsolete.

Your local Gates Field Engineer is an experienced, fully-qualified drive design expert. Contact him for drive design help.

The Gates Rubber Company Denver, Colorado



Gates Super HC V-Belt Drives

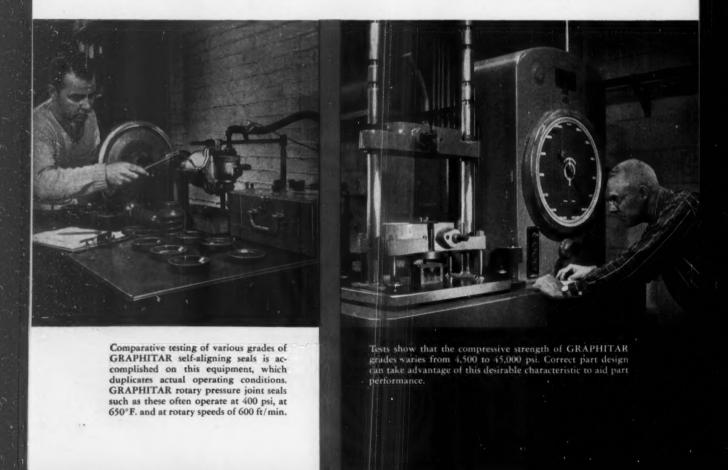
GRAPHITAR

(CARBON-GRAPHITE)

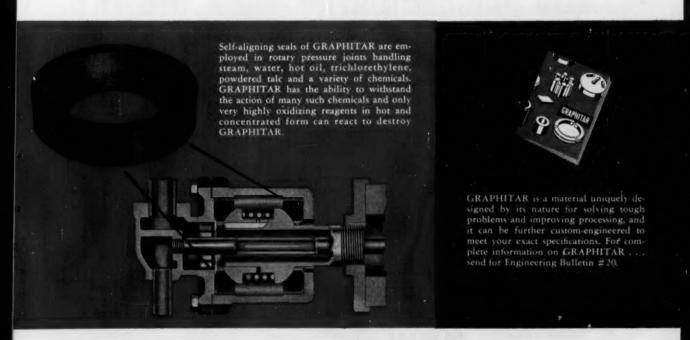
FOR PERFORMANCE

Superior performance and unusually long service life, even in tough applications, is practically second nature to parts made of GRAPHITAR. That's because they combine GRAPHITAR's chemical stability, heat resistance, low coefficient of friction, adaptability to self-lubrication, mechanical strength, hardness and light weight. An everyday application of GRAPHITAR that illustrates well its versatility and remarkable performance can be found in the face-type valves employed in bulk station gasoline meters.

These valves incorporate GRAPHITAR seats. Here, GRAPHITAR's corrosion resistance, chemical inertness and resistance to expansion or contraction under rapid temperature changes, allow the valves to provide a leak-tight seal with excellent wear characteristics. These same characteristics are necessary for good performance wherever steam, gas and chemicals must be handled under the most adverse conditions. Perhaps your product can benefit from the top performance of GRAPHITAR, a unique and versatile engineering material.







THE UNITED STATES GRAPHITE COMPANY



DIVISION OF THE WICKES CORPORATION, SAGINAW 7, MICHIGAN GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

NEW

Instrument Bearings

from NEW HAMPSHIRE

Let You Beef Up The Shaft

Without Increasing

Bearing O.D.

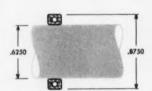
Here are four new opportunities to design shaft-to-housing relationships not possible with other bearings. As shown in the sketches, thinner bearing cross sections permit extralarge Bore-to-O.D. ratios.

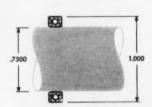
This new series is manufactured to ABEC-5 precision standards or better, of stainless 440C steel, with plastic crown retainers which absorb lubrication.

BORE DIAMETER +.0000 +.0000 00020002	DIAMETER WID	WIDTH + .000	0 BEARING		LAND DIAMETERS		BALLS		
	001 NUMBER	RADIUS	INNER	OUTER	NO.	SIZE	RATING		
.3750	.6250	.1562	SR620T	.010	.457	.542	12	1/16	81
.5000	.7500	.1562	SR824T	.010	.587	.672	16	1/16	95
.6250	.8750	.1562	SR1028T	.010	.712	.797	18	1/16	98
.7500	1.0000	.1562	SR1232T	.010	.837	.922	22	1/16	108









Write for full information or call in your New Hampshire Sales Engineer for application assistance.

HAMPSHIRE BALL

BALL BEARINGS, INC.

PETERBOROUGH, N. H.



WHY STOCK DC CONTACTORS AND RELAYS?

... when you can assemble more than 100 devices from General Electric "building-block" components

There's no need to carry a large inventory of d-c contactors and relays ... just to be sure you have the correct device when you want it!

"Building-block" design of General Electric contactors and relays permits you to assemble more than 100 different devices—right in your own plant—from a stock of as few as a dozen standard components.

G.E.'s "universal" contact block is the building unit for all types of contactors and relays. Choice of standard frame-and-coil assembly with proper combination of contact blocks and standard assembly kit permits the variation in devices to meet your specific application requirements.

Three complete contactor lines and six relay lines—for general-purpose,

mill-duty, overload, and timing functions—can be assembled using this unique approach.

Rely on General Electric for all components
—General Electric also has complete
lines of plate rheostats and resistors.
For additional information, contact your
General Electric Sales Representative
or mail the coupon below. Industry
Control Department, Salem, Va.

GENERAL

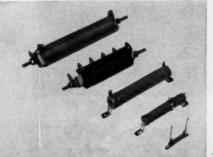


ELECTRIC

Circle 269 on Page 19

Resistors—vitreous-enameled and wire- and ribbon-wound types from 5 to 1210 watts. Fixed, slide-wire, or tapped types available.

Plate-type rheostats—windings are completely encased in metal to give longer and more reliable service for any application.

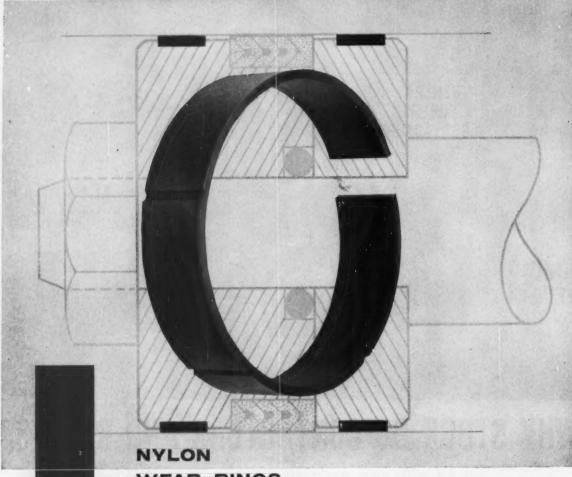




To: Section C784-31
General Electric Co.
Schenectady 5, N. Y.

Please send the following bulletins:
GEA-6621—D-c contactors and relays
GEA-6592—Resistors
GEA-6474—Plate-type field rheostats

Name
Company
Address
City
State



WEAR RINGS

for Hydraulic-Pneumatic Service

New—prevent damage to piston cylinders with new Garlock Nylon Wear Rings. Greatly superior to materials previously used, the rings (designated Style 9003) are smoother and harder. This means that no foreign particles in the cylinder can be picked up or become imbedded in the ring and consequently score the cylinder walls. For you, it adds up to smooth, unhampered piston operation, greater overall efficiency, and longer cylinder and packing life.

Offer all the fine advantages of Nylon. Garlock Nylon Wear Rings provide satisfactory service in temperatures as high as $+350^{\circ}$ F. They are unaffected by the normal fluids used in hydraulic cylinders. They exhibit greatly-improved wear qualities and life expectancy. Garlock Nylon Wear Rings are available in a wide range of sizes for new equipment, and will normally fit existing grooves in present equipment. You can order Nylon Wear Rings in nominal diameters (inches) from 2.005/2.010 to 7.005/7.015, and in widths (inches) from .500/.490 to .625/.615, depending on diameters. Special sizes also available.

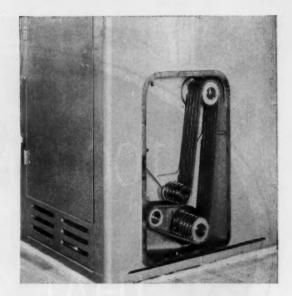
For more information, call your local Garlock representative. He is at the nearest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalog AD-179. Garlock Inc., Palmyra, N. Y. Canadian Div.: Garlock of Canada Ltd. Plastics Div.: United States Gasket Company. Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

As bearings to prevent wear between piston and cylinder (top), Gariock Nylon Wear Rings are gaining fast acceptance among leading manufacturers of hydraulic-pneumatic equipment, such as Hough Loaders (below).



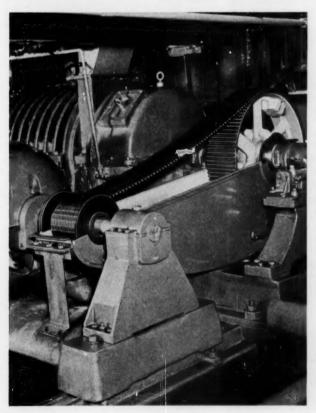
GARLOCK

FOR DRIVING A SERIES OF SHAFTS on fixed centers, Link-Belt silent chain assures positive transmission of power. On applications requiring reverse rotation of shafts, Link-Belt duplex silent chain is capable of driving wheels from either side of chain.



Link-Belt silent chain

for drives that can't afford to slip



Smooth, positive engagement assures full power transmission

Continuous, nonslip operation for many years with only routine attention—this is a common experience with Link-Belt silent chain. Where other types of drives are impractical due to slipping tendencies, this modern chain drive delivers positive transmission of full-rated horse-power.

Link-Belt silent chain assures efficiency for either large or fractional-horsepower drives. Easy assembly in tight spaces permits built-in drives, compact housings. Close grouping of equipment saves valuable floor space. High humidity, temperature have no effect on performance. Ratios as high as 10-to-1 are accommodated on relatively short centers.

Available in a full range of sizes. For complete information, call your nearby Link-Belt office. Ask for Book 2425.

WHERE SPACE IS LIMITED, compact Link-Belt silent chain drives permit close grouping of equipment. High ratio reductions are easily accommodated on relatively short centers.



SILVERSTREAK SILENT CHAIN DRIVES

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs; Switzerland, Geneva. Representatives Throughout the World.

1000 INCH-LBS. TORQUE THAT SMALL

You can use these new Globe planetary gearmotors to replace units 5 to 10 times as large and heavy. They slash pounds of dead weight from your design—give you up to 500 inch-pounds continuous duty or 1000 inch-pounds intermittent duty torque. Here's enough brawn to handle aircraft, missile and other high-quality, high-reliability jobs. Smaller gearbox shown above gives 200 in.-lbs. intermittent, 100 in.-lbs. continuous duty.

Globe's brand new planetary gearing system provides 22 ratios from 1.87:1 to 5211:1. Stage efficiency of 90% or better has been achieved by using heavy duty precision ball bearings on every gear and on the output

shaft. Heat treated gears and hardened output shaft withstand enormous turning and bending moments. Type BD and BL gearmotors fit your application exactly, using 21 standard armature windings for 4 to 115 v.d.c. power—custom design for your application can include speed governors, brakes, and clutches. 13/4" flange gearmotor typically weighs 11/2 lb.; 3" flange high-torque gearmotor weighs 43/4 lb. typ.

Let Globe engineers review your application early in the design stage. Prototypes furnished promptly. Write for Bulletin BPG. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio. Phone BAldwin 2-3741.

GLOBE INDUSTRIES, INC.

PRECISION MINIATURE A.C. & D.C. MOTORS. ACTUATORS, TIMERS, CLUTCHES, BLOWERS, FANS. MOTORIZED, DEVICES





is for Perfectionists

A layman picks up two drawing pencils and sees no difference. But the *Perfectionist* knows. His trained eye instantly observes the rich, crisp opaque line that *stays* black without flaking or feathering.

His fingers sense the low index of friction which gives him smooth, effortless strokes. He sharpens CASTELL, testing for non-crumbling, strong-textured lead and non-splintering wood. Next he tries chisel point, then needle point. He checks the perfect balance between coverage and easy erasability on paper and vellum, on Cronar and Mylar base films. When the print comes out of the machine, he examines it with a magnifying glass.

Then he knows the satisfaction that only a Perfectionist feels when he finds the perfect working tool. 20 superb degrees, 8B to 10H. Join the masters of your profession. Buy CASTELL, call your dealer today.

#980036 Locktite Tel-A-Grade Lead Holder with no-slip, functional grip that's kind to tired fingers Bull dog clutch Unique degree indicator Carries 2-year guarantee Castell Drawing Leads #9030, identical in grade and quality with world-famous Castell drawing pencil Usable in all standard holders, but perfect for Locktite Draws perfectly on all surfaces, including Cronar and Mylar base films 78 to 10H, and a kaleidoscope of colors



A.W.FABER-CASTELL
Pencil Co., Inc., Newark 3, N. J.

Our Bicentennial year—1761-1961 200 years of uninterrupted manufacturing experience.

ELIMINATE UNNECESSARY ASSEMBLY COSTS



CF (Cam Follower) SERIES

The original and still unsurpassed anti-friction roller bearing cam-follower bearing that adds efficiency at less cost to cam actuated, track and support roller applications. Built with full roller complement and integral stud, the CF series design provides high radial capacity and shock load protection in a compact roller with its own shaft. Easily applied and available in roller diameters of 1/2" to 4".

SCF SERIES.

Sealed to keep contamination out and lubricant in. It is dimensionally interchangeable with the CF bearings. A turned groove in the center of the outer raceway bore provides a permanent lubricant reservoir to approach life-time lubrication requirements. Can be easily re-lubricated.

CYR (Cam Yoke Roller) SERIES

The CYR series increases the adaptability of the CF bearing to all types of automatic machinery involving cam action or controlled-motion machine parts that require guide or support rollers. An inner ring replaces the stud for cam yoke roller mountings.

SCYR SERIES

This series provides a fully sealed Cam Yoke Roller type bearing. It is dimensionally interchangeable with the CYR bearings.

> McG!LL MANUFACTURING CO., INC., Bearing Division 200 N. Lafayette Street, Valparaiso, Indiana

for the ultimate in:

- . RADIAL CAPACITY
- . SHOCK RESISTANCE
- SPACE ECONOMY



SCYR SERIES (sealed)

Write for Catalog No. 52-A for full information on McGill's needle roller bearings, and cam followers. Ask about recommendations for high precision special ball and roller bearings.



engineered electrical products

precision needle roller bearings

104

Circle 274 on Page 19

MACHINE DESIGN



NEW DESIGN FREEDOM FOR YOU...

R&M unshackles your designers' hands by providing a wide range of Universal Motors for powering portable tools, household appliances, business machines and many other products. R&M Universals are available 1/50 to 1 HP, AC and DC operation, fixed or reversible rotation, open or totally enclosed, with rigid bases or end mounting. Motors feature high operating speed, high starting torque, adaptability to speed control, and light weight per horsepower. Quality materials, skillful engineering and precision manufacture assure long, dependable life and quiet, vibrationless operation. Besides standard ratings, many special designs are now engineered and tested due to past custom-designing... or R&M will custom-design a motor for your specific application. Write today for R&M Bulletin 444-MD



ROBBINS & MYERS, INC., Springfield, Ohio

Fractional and Integral HP Electric Motors • Electric Hoists and Overhead Traveling Cranes • Moyno® Industrial Pumps
Propellair® Industrial Fans • R & M-Hunter Fans and Electric Heat • Trade-Wind Range Hoods and Ventilators
Subsidiary companies at: Memphis, Tenn., Pico Rivera, Calif., Brantford, Ontario.

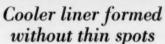


Foam plastic makes this boat unsinkable

The hull of this 11 ft. sailboat, designed to sell for under \$100, is one solid piece of foam plastic—DYLITE® expandable polystyrene. Because of its tight cell structure and light weight, this amazing material has unmatched buoyancy. The boat stays affoat even if it's completely flooded. It can't become waterlogged because DYLITE doesn't absorb water. The hull weighs only 30 pounds, yet it can support over 500 pounds. Another Koppers plastic, Durethene® polyethylene film, is used in the durable yellow sail. Boat manufactured by Snark Products, Inc., Fort Lee, New Jersey.







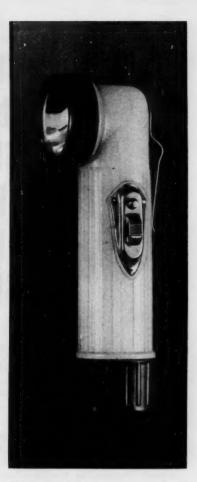
The interior liner of this Hamilton-Skotch picnic chest is thermo-formed from SUPER DYLAN® high-density polyethylene. This impact-resistant plastic is used because it's the only polyethylene that can be formed into this difficult deep-draw piece-without producing thin spots or mold marks. The seamless liner won't leak, absorb food odors or water. Its smooth, white finish can't stain, discolor, rust or corrode—it's easy to keep clean. Bottles, cans and chunks of ice won't mar or crack its tough surface. Cooler Chest Manufactured by The Hamilton-Skotch Corporation, New York 16, New York.



Foam trays simplify toy packaging

A. C. Gilbert Company uses DYLITE expandable polystyrene trays because they completely eliminate costly interior packing materials. DYLITE trays are strong, good looking, easy to assemble and load—they save on labor costs. They also cut shipping costs because they're extremely lightweight.

DYLITE packages come in any size or shape; they fit firmly around the product and protect it from shipping damage. They make an attractive display because their smooth, colorful surface won't smear, chip or flake. DYLITE parts molded by Sullifoam Products, Willow Grove, Pennsylvania.



Flashlight guaranteed not to break

This new right-angle flashlight case is guaranteed unbreakable because it's molded from strong Dylan® polyethylene. It's colorful, can't chip or flake. Unlike metal flashlights, it won't rust or corrode and it's completely acid-proof.

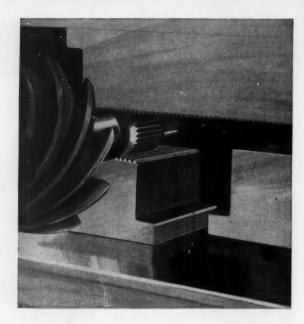
Koppers has a wide range of polyethylenes available for almost any application. They come in densities from .914 to .953 gm./ml. By varying density, molders or design engineers can get varying degrees of stiffness, heat distortion and tensile strength. Remember too, that polyethylenes can give you a wide range of colors. Flashlight manufactured by J. P. Gits Corp., Chicago, Illinois.

KOPPERS PLASTICS

Find out how Koppers family of plastics can help improve your product at less cost. For more details write Koppers Company, Inc., Plastics Division, Dept. 1529, Pittsburgh 19, Pa.



WHAT "CHIPLESS MACHINING" DOES FOR PRODUCT DESIGN



ROTO-FLO cold forming . . . chipless machining . . . offers the designer 9 ways of improving his product and cutting its cost as compared with conventional machining of similar parts:

GREATER STRENGTH . . . Since the ROTO-FLO process produces finished shapes by displacing the metal (cold working), density of grain structure is increased. Permissible torque loadings of shafts, for example, are increased about 50% when processed in this manner instead of being machined.

HEAVIER LOADS... For an equal 'finished' diameter, the higher strength permits increased loads. On toothed parts, tooth shear strength is increased 15% to 35% due to the improved grain structure and higher density.

LONGER FATIGUE LIFE... The cold working operation not only increases density of grain structure, but produces a better grain flow and reduces stress concentration. There is thus greater freedom from fatigue failure. Permissible torque loadings for shafts, are increased over 50%.

LESS WEAR . . . Wear is decreased because of the improved grain structure, higher density and finer finishes obtainable.

LESS BACKLASH... The original fit of ROTO-FLO processed parts prevails over longer periods due to the finer surface finish and decreased wear.

FINER FINISH... Finishes as low as 3 to 6 microinches are being obtained in routine production with the ROTO-FLO process. The long tool life assures retention of accuracies within ASA specifications over long runs. LESS MATERIAL... Since the process displaces metal outwards, increasing the final diameter, the blank—for the same minimum cross-section of the finished part—can be of smaller diameter. In addition, it is sometimes possible to reduce the finished OD of the part (as compared with a machined part) because of the higher inherent strength of the cold-worked part. In any event, you use ALL the material you start with instead of wasting a lot in the form of chips.

LOWER COST . . . In addition to the materials savings made possible by reduction in blank size, the ROTO-FLO process usually reduces tool cost far below that required when machining the same part. Further, the extreme rapidity of the process (up to 30 times faster than cutting) permits greater production per machine hour.

DESIGN FREEDOM... Cold forming ... instead of cutting ... opens new horizons for improved design of parts lending themselves to ROTO-FLO processing. Part designs can often be simplified. Shoulders present less of a problem.

WHERE YOU CAN USE IT

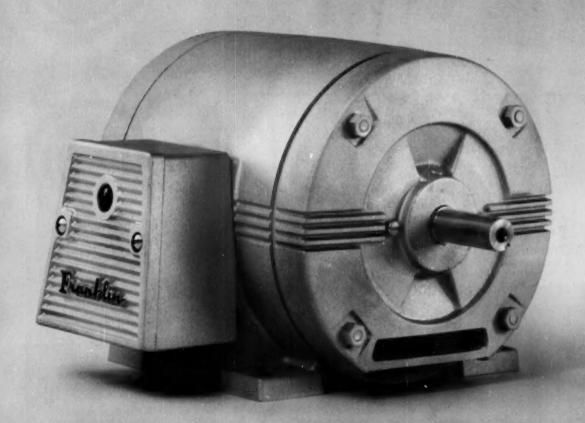
The ROTO-FLO process is ideally suited for the production of parts which require splines, threads, grooves, serrations, etc. Splines may be tapered or straight, spur or helical. Splines and threads or grooves on the same part usually can be produced in a single operation. Parts may be of a wide range of materials—from SAE 1040 to Nitralloy to heat-treated stainless, plus brass, aluminum, etc.



Let us help you improve your product and cut costs at the same time. Ask for Bulletin RF-60, Michigan Tool Company, 7171 E. McNichols Rd., Detroit 12, Michigan.

ALL-NEW STANDARD MOTORS MADE OF ALUMINUM

LIGHTER THAN CAST IRON! STRUCTURALLY STRONGER THAN CAST IRON!



Available NOW in single-phase and polyphase, from 1 to 71 H.P.

More facts available NOW on the next page ...

HOW LONG WOULD
IT TAKE YOU
TO WIRE UP
THIS
NEW
MOTOR



LESS THAN

60 SECOND

Tough yet lightweight aluminum means lower shipping costs, easier assembly line handling, lower production costs.



Protective devices stay where they belong—inside. It's the only polyphase motor with this



Burly bearing system keeps grease in the bearing for longer motor life. Bearings are prepacked and double-shielded.



Franklin motors come with the terminal board already wired. All connectors in up position—it's wired 440V. All connectors in down position, it's wired 220V. All you do is connect line leads.

FRANKLIN'S NEW STAB-TYPE TERMINAL BOARD IS PRE-CONNECTED TO YOUR SPECIFIED VOLTAGE!

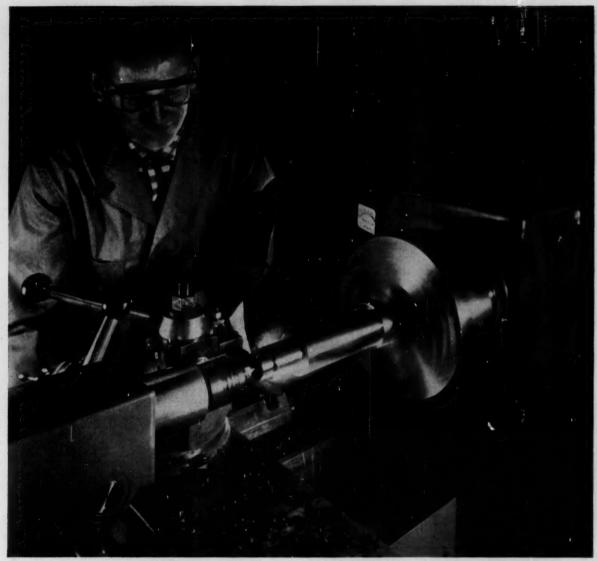
You specify the voltage. We pre-wire the motor. Your production people connect three line leads and...that's it! No costly hours lost on wiring and taping. Mistakes are virtually impossible. Wires can't be crossed.

When all stabs are connected in the up position, the motor is wired 440V. When all stabs are in the down position, 220V! Simple. See this new Franklin integral of aluminum and write for free color brochure.

Franklin Electric Co., Inc.



BLUFFTON, INDIANA



Heavily stressed parts made from tough, hardened 4615/20 nickel steels

help this Barber-Colman lathe handle heavy work loads with close tolerances.

Nickel alloy steels safeguard the working accuracy of this Barber-Colman lathe

For sustained high-volume production without loss of accuracy...

...here's where Barber-Colman uses 4615/20 nickel alloy steels for vital components:

All these parts are made from AISI 4615 steel (1.8% nickel):

- · tailstock spindle
- · spindle front cap
- reverse rod bushing
- · tailstock binder shaft
- tanstock binder shart
 handwheel pinion shaft

And the main headstock spindle is made from AISI 4620, to give this critical component built-in resistance to torsion, fatigue, and frictional wear...

AISI 4615 and 4620 steels, carburized and hardened, provide a hard case for wear resistance, plus a tough, strong core to withstand shock-loading. In addition, both possess good resistance to distortion in heat treatment...a positive way to help cut costly finish-machining.

When you order or design machine parts, remember these tough, wear-resisting nickel alloy steels. And for engineering information to help you select the best metal for a particular job, write to INCO, outlining your problem.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street INCO. New York 5, N. Y.

INCO NICKEL

NICKEL MAKES STEEL PERFORM BETTER LONGER

if you use TORQUE MOTORS

... the name is Peerless

The torque motor, unlike any other electric motor, is a special from the word go. That situation alone makes Peerless one of the best sources for torque motors in ratings from 2 oz. in. to 200 lb. ft.

Torque motors deliver maximum rated torque without damage to the windings when stalled across the line at full voltage for predetermined periods. Peerless also builds torque motors which provide a nearly constant torque while operating at less than synchronous speeds.

All standard frame sizes; all types of mountings; high torques; special paint and varnish treatments;

and Class A, B and H insulation are available from Peerless. Torque motors require unusually close cooperation between the motor supplier and the customer's engineers. This cooperation is a Peerless specialty. We will work with you to produce the one torque motor that powers your product best.



Weather-Tight Special Flange



Explosion-Proof Torque Motor with Brake



Special Flange Reversing Hoist Motor Single Phase

Comparative Speed-Torque Curves of NEMA
Design B Motor and Typical Torque Motor

100
90
BB TORQUE MOTOR

TORQUE MOTOR

TORQUE MOTOR

% OF LOCKED TORQUE

The speed-torque curve varies from that of a conventional motor. The torque motor curve is almost linear. Maximum torque occurs at the stalled position. For this reason, torque motors are used most often where a holding or resisting force is required.

NEW TORQUE BULLETIN-This bulletin outlines basic facts about Peerless torque motors and shows applications. It is available FREE. Write for it today.



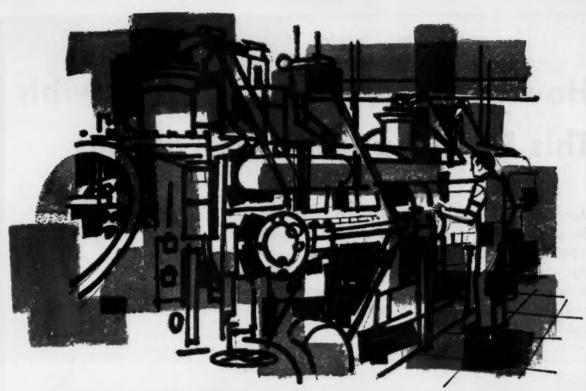
Peerless Electric Division, H. K. Porter Company, Inc., Warren, Ohio

PEERLESS ELECTRIC DIVISION

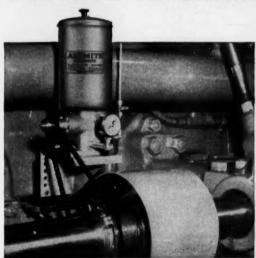


H.K.PORTER COMPANY, INC.

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.



No other centralized lubrication system can offer the advantages of Accumite with the ALEMITE MECHANICAL PUMP AND TIMER!



Close-up of the Alemite Mechanical Pump and Timer driven by timing shaft by means of a chain and sprocket.

By utilizing a chain and sprocket to transfer rotary motion to an Alemite Mechanical Pump and Timer you can supply efficient, automatic Accumite Centralized Lubrication to as many as 400 points or bearings. That's over 30 times the capacity of other pumps! The Alemite Pump eliminates the "rat's nest" of lines other systems require—serves all bearings with a single line. Shots are measured at the bearing, not at the pump. Line length is no factor and any size shot from .00055 oz. to .012 oz. or more can be delivered to any point. Two more Alemite advantages are the big capacity 5-pint reservoir and an alarm system assuring accurate, positive lubrication.

The Alemite Pump and Timer is completely mechanical, uses no air or electricity. Cam operated valve closes at intervals determined by the pump input shaft speed to deliver positive, measured amounts of lubricant to each point in the system. Measurement is by piston stroke, wear not a factor, pressures remain constant and can be read on any type gauge.

Contact your local Alemite distributor or write for free illustrated literature on the Alemite Mechanical Pump and Timer and the Accumite Centralized Lubrication System.

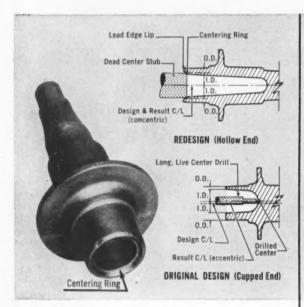
In Canada: Stewart-Warner Corporation of Canada, Ltd., Belleville, Ontario



Dept. BB-61, 1850 Diversey Parkway, Chicago 14, Illinois

How to Improve Parts Design with This Fresh Approach to Forging

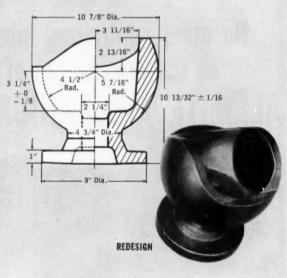
Many parts in use today are better as a result of design refinements suggested by COMMERCIAL's forging experts. Below are examples of COMMERCIAL upset forgings which demonstrate how these design refinements have resulted in superior parts for the OEM at lowered cost. These examples may appear to you as unusual in design—and this is the point...



Forging Redesign . . . Cuts Così, Eliminates Tool Breakage, Cuts Scrap

Original design of axle spindle forging required chucking on the O. D. to enable center drilling of both ends. Part was held between drilled centers for overall machining. Concentric cupped axle end was center drilled blind with long, live center drill. O.D. and I.D. concentricity was difficult to maintain—causing eccentric drill centers. Result: tool breakage and machining scrap.

COMMERCIAL's redesign calls for a centering ring on inside edge of hollow end, forged without concentricity problem. Lead edge lip protects this important centering ring. The part can now be held for overall machining by a dead center stub engaged in the centering ring. Result: center drilling of open end not required, tool breakage eliminated, no machining rejects, metal savings.



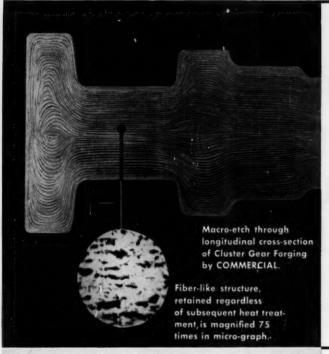
Unusual 80 lb. Forging . . . Reduces Cost, Replaces 95 lb. Casting

Ball joint housing for heavy duty steer and drive mechanism...formerly a steel casting. Field failures were traced to hidden metal faults. The housing was unable to withstand shock loadings encountered.

Problem: redesign for required strength-part to be no larger, no heavier, same shape.

Solution: an upset forging of unusual shape—flanged on one end, belled on the other, open at both ends. COMMERCIAL collaborated in the design and produced the part free of hidden metal flaws with sound, tough metal throughout—failures eliminated. Plus... weight saving over 15%, saving in machining cost 10%, greater strength-to-weight ratio.

When it's a vital part,

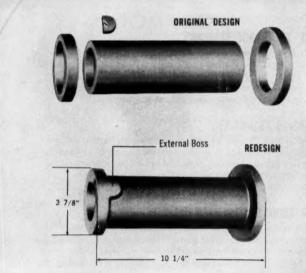


Metal Quality Facts

Forgings start with "Forging Quality" rolled steel ... steel that is closely controlled in its making for the purpose of eliminating defects and obtaining soundness-surface and interior. Such quality steels have been hot worked to obtain maximum development of their potential physical properties. Grain structure has been refined into a fibrous flow in the direction of working.

Mechanical hot forging of "Forging Quality" steel forces the metal in its plastic state to conform to specified shapes and achieves a vast improvement in its "as rolled" metal quality. Forging kneads the metal into a dense mass of strength and toughness and positions it into commercially exact dimensions and shape in all directions.

Upset Forging in closed dies produces by squeeze pressure a "looped" grain flow and permits concentration of grain density at points where the service stresses are calculated to be the greatest. Also, control of the directioning of the inherent fiber-like structure provides for maximum strength of the metal at required stress points. Not only are the properties of the metal improved in all directions but also the metal structure is refined and compressed resulting in a structural uniformity that renders the metal remarkably free from concealed defects.



One Piece Forging . . . Lowers Cost, **Eliminates Four Piece Weldment**

Blank for hydraulic cylinder outer barrel used to position Nike missile...originally a weldment—a tube, two flanges and a boss.

Problem: cut unit production time to meet crash program schedule, reduce assembly and machining cycle, increase strength-to-weight ratio.

Solution: a difficult upset forging because of external boss. COMMERCIAL tooled and produced the part in one piece to print. Assembly time eliminated, less distortion...improved machining conditions, forged to closer tolerances, uniform metal quality, added tensile and torsional strength due to controlled grain flow, strength-to-weight ratio increased, delivery schedule satisfied.

design it to be FOREED



Advantages of Upset Forgings

- Uniform strength, toughness and high fatigue resistance insure longer, more dependable service life for equipment.
- Parts made closer to finished dimensions-cuts scrap, reduces machining and finishing time.
- · Components can be assembled by simple production methods into complex parts.
- Uniform response to heat treatment gives desired physical properties of precise degree.
- Higher strength-to-weight ratio obtainable-a vital factor in the design complexity of parts for the future.

Features of Upset Forging by COMMERCIAL

- Batteries of upsetters from 11/2" to 8"-custom or production runs.
- Hydra-Jet descaling prior to forging reduces imbedded surface scale.
- Magnetic particle depth inspection to detect metal faults before shipment.
- "Task Forging" team steeped with experience in producing the unusual upset forging.

While designs are on the board, call on COMMERCIAL'S "Task Forging" team to collaborate with you-send print or sketch, sample or prototype. Address: Commercial Shearing & Stamping Co., Dept. S-25, Youngstown 1, Ohio.

GOMMERGIAL shearing & stamping

AIMING THE WORLD'S MOST ACCURATE SHOT



Hitting a marble placed at the far end of a block-long playground is child's play compared to the performance of an intercontinental ballistic missile. Our ICBMs have proved capable of striking within two nautical miles of a target a quarter of the way around the world. Holding ICBMs on target are inertial guidance gyros that rotate on the world's most precise and dimensionally consistent ball bearings—made by Barden.



Motor-driven gages and recorder provide actual traces to document tolerances held on 20-Millionths bearing parts.

20-Millionths Bearing Tolerances – Maximum	INNER	OUTER RING
Roundness (Bore or O.D.)	.000020"	.000020"
Taper (Bore or O.D.)	.000020"	.000020"
Side Runout (with Bore or O.D.)	.000020"	.000020"
Raceway Roundness	.000020"	.000020"
Raceway Parallelism with Side	.000020"	.000020"
Radial Runout	.000020"	.000020"
Parallelism of Sides	.000020"	.000020"

.000020" TOLERANCE BEARINGS

To meet ICBM requirements, 14 ball bearing tolerances had to be reduced to 20 millionths of an inch — a 10-fold advance in the state of the art. Today "20-Millionths" ball bearings are in volume production at Barden — probably the most precise mechanical assemblies ever manufactured in quantity.

NEW GAGING TECHNIQUES

To develop and produce 20-Millionths bearings, Barden devised a radically new approach to production and gaging. For example, a whole new group of special gages had to be designed, utilizing two principles new to high-precision mass production — motor drives and recorded readouts.

EACH BEARING DOCUMENTED

All inner and outer rings are numbered serially, as are the bearings assembled from these parts. When shipped, each bearing is accompanied by documented evidence of compliance with dimensional and functional specifications. A tally sheet backed up by gage traces shows the actual dimensions of inner ring and outer ring of each bearing, all accurate within 20-millionths of an inch. This tolerance, a maximum, is usually bettered, with dimensions often held within 5 or 10 millionths.

PROTOTYPES AVAILABLE

Prototype quantities of 20-Millionths angular contact bearings are now available; .250000" bore, .625000" O.D. in two .000020" calibration groups for bores and O.Ds. For further information, ask for 20-Millionths Booklet TWM.

Barden is a major producer of precision ball bearings for instruments, weapon systems, computers and other high quality equipment.

for reliability...specify

BARDEN



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THE BARDEN CORPORATION, 2 0 8 Park Ave., Danbury, Conn. Ploneer 3-9201 Western Office: 3850 Wilshire Blvd., Los Angeles 5, Calif. DUnkirk 5-0034



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a hose-clamp screw in carbon steel or
stainless—call on National Lock. Utilize our
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fastener problem at lowest cost.
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Cleveland Worm & Gear Division Eaton Manufacturing Company

Eaton Manufacturing Company 3270 East 80th Street • Cleveland 4, Ohio



In service 40 years... never overhauled!

After 40 years of continuous service at Alcoa's New Kensington, Pennsylvania plant, this rugged Cleveland Worm Gear Speed Reducer was slated for an overhaul.

As this unit—which continuously drives a foil mill—had never been opened before, a thorough, painstaking inspection was made by Cleveland service engineers. They found the reducer required only a new worm radial bearing to put it in top notch operating shape. Even the gear's working face was in almost factory-new condition—after 40 years of rugged, heavy-duty operation!

As our engineers left the plant, Alcoa personnel remarked, "Well, we'll see you again in another 40 years."

We are extremely proud of this experience at New Kensington. It serves to point up our belief that building product quality and performance in Cleveland Reducers is still the main reason we are in this business. We know from experience that industry welcomes quality products—and we will continue to produce them.

* Today, some capital goods producers seem to be guided by the philosophy that in this age of rapid change in manufacturing methods and equipment, the resulting high rate of obsolescence does not justify the costs entailed in building long operating life into a product. This is not true of Cleveland—and never will be.

Why not talk to your Cleveland Representative and get the latest information on Increased HP Worm Gear Speed Reducers. Or write for your free copy of our latest illustrated literature—it contains the story of today's finest reducers.



RINGS IN YOUR PRODUCT?



Let Amweld show you how much flash butt-welded rings can cut your costs!

Amweld flash butt-welded rings will curb your ring costs two ways. One, you'll save on metal, because Amweld can form your ring from stock produced to or near finished dimensions. Two, you'll save on machining, because unnecessary metal is left at the mill—not machined away in your shop.

Through close evaluation of circular components and assemblies and close-tolerance fabrication of rings, Amweld saved its customers more than one million dollars last year alone. Savings were recorded by manufacturers in almost every industry—construction equipment, motors and generators, fabricated metal plate work, mechanical power transmission, transportation and materials handling, also jet en-

gines and missiles where Amweld's ability to flash weld exotic materials to exacting specifications offers proof of Amweld quality.

Investigate now! To see how Amweld saved Gar Wood 19% and 26% on rings for truck-mounted cranes, send coupon for your free copy of Amweld Application Study C-1. Then let your Amweld representative show you how much flash butt-welded rings can cut your costs on any part that's round!

fabricated metal plate work, mechanical power transmission, transportation and materials handling, also jet en-American Welding & Manufacturing Co. Dietz Road, Warren, Ohio Yes, send Gar Wood Application Study along with full details on Amweld flash butt-welded rings as a cost reduction opportunity. Name & Title

Amweld sliced 19% off the rough ring cost of the 50"-diameter, 1020 carbon-steel gear used in the Gar Wood crane's rotating table. Savings on rings of 23" and 28" in diameter totaled 26%. Mail coupon today for the complete Amweld savings story.

WITH 2,000 STANDARD UNITS AVAILABLE PUROLATOR HAS THE RIGHT FILTER FOR EVERY FILTRATION APPLICATION

The narrow tolerances and precisely-machined parts found in today's equipment demand proper filtration for maximum output and long life. In fact, filtration has become a basic tool of the product designer, Shown are just four areas in which standard Purolator filters can result in improved design...better performance...reduced wear. Purolator is the world's most experienced manufacturer of filters. Whatever kind of filtration your design calls for, chances are standard Purolator filters will do the job. Consult your nearest Purolator office. Or, if yours is a specialized application, we'll design-and build-a filter to fill your needs. Write: Purolator Products, Inc., Rahway, New Jersey.

TION Purplator's "selective" Improper filtering of lubricating oils can also remove costly, en-1. AIR INTAKE FILTRATION. gine-protecting additives. Purolator dry air filtration posi-Controlled porosity of the tively prevents all contaminates from entering engine. After be-

Micronic® element of a Purolator lubricating oil filter removes particles of dirt measured in microns

2. LUBRICATING OIL FILTRA-



(.000039-inch). Yet, it never removes needed additives. These Micronic® elements are unaffected by high temperatures or water. Never develop soft spots or channel.

What's more-a Purolator Micronic® filter of correct size can handle full lubricating oil flow for even the largest engines. This eliminates the need for partial flow systems - whereby many harmful contaminates can remain in the lubricating system.

filtration leaves additives in 3. GASOLINE ENGINE FUEL FILTRATION. Series G-144J heavy-duty or detergent oils. FILTRATION. Compact Purolator GF-11 Series fuel filter is adaptable to many gasoline engines. Particles of dirt as small as 10 microns in the fuel system can choke and stall a gasoline engine. Carburetors like the modern 4-barreled units especially need positive filtration for efficient operation.



Purlator's GF-11 Micronic fuel filter is especially designed for the job. Used on many 1961 cars, it can be incorporated equally well into the fuel system of many gasoline engines.

Measuring only 3" x 1%", it can be easily installed either horizontally or vertically. Fully 70 square inches of filtering surface removes all contaminates down to 5 microns. Filter is designed as a throw-away unit...good for over 5,000 miles of operation.

4. DIESEL FUEL AND LUBE OIL metal edge filters offer permanent, uninterrupted filtration for fuel and lube oils. Standard equipment on many of the largest, most modern diesel engines, the G-1441 filter requires an absolute minimum of maintenance.



Made of precisely-spaced metal ribbon wound in cylinder form, the filter element lasts indefinitely. Cleans by an occasional twist of the hand wheel on top of the unit which rotates the filter element against a fixed knife blade. No need to cut off the engine or to interrupt the flow of fuel.

Spacing of ribbon determines degree of filtration-which ranges from 25 to 500 microns. Fine filtration is recommended for fuels. Less fine filtration for lube oils.

of all contaminates even if one filter element should be out of operation.

engine. Purolator's new 2-stage

filter continues to remove 99.98%

coming clogged with dirt, con-

ventional oil bath filters continue

to let damaging, dust-laden air

into the engine. On the other hand, a dry type filter like a Purolator Micronic® unit positively filters all air entering the

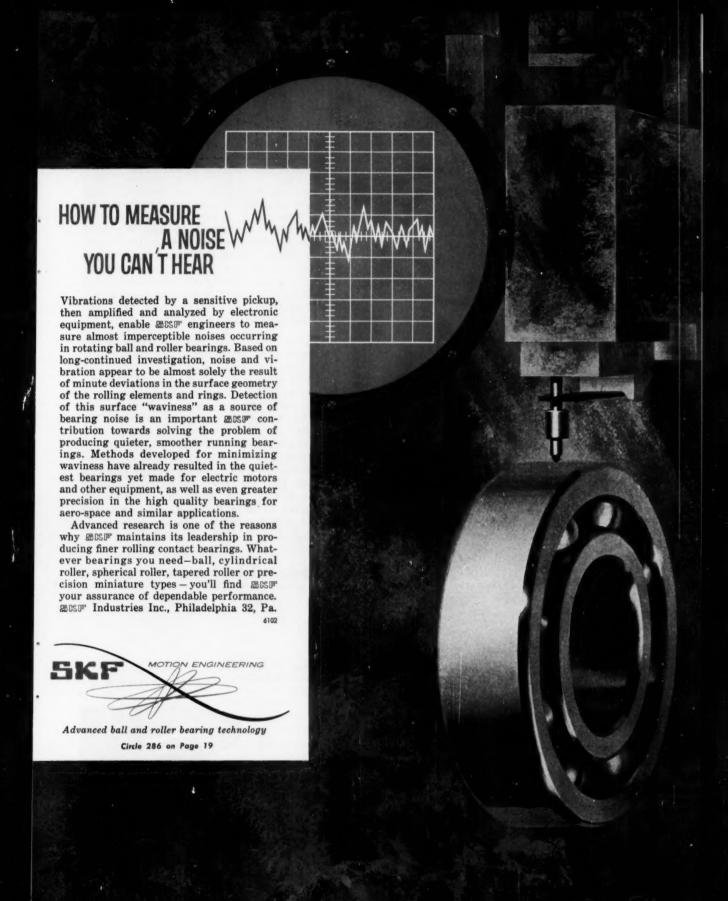
Replacing a Micronic® filter element is easy too. Takes less than a minute. And since there is no oil to spill . . . no oil level to maintain . . . the filter can be installed anywhere on the engine.

Filtration For Every Known Fluid

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Here's plenty of power for equipment requiring normal thrust vertically mounted motors. Wagner® Vertical Solid Shaft Motors provide power without problems for your pumps, mixers, agitators, axial fans, centrifuges, presses . . . anywhere you need a vertical motor drive with plenty of stamina.

Wagner Vertical Solid Shaft Motors are end-mounted, squirrel-cage type with a NEMA Type "P" base that is precision-machined to mate with equipment. Smooth running under cyclic loads, they won't labor or stall...

conform with NEMA Design B motor requirements in all respects. Their cast iron construction is simple and rugged . . . stands off corrosion . . . stands up to rough, tough treatment. Here are motors that are designed to give you economical, maintenance-free service the year 'round, indoors or out.

Wagner "Stand-up" Motors are available in ratings of 1 hp and larger with nominal full load speeds of 3500, 1750, 1160, or 870 rpm, and can be supplied with a completely dripproof enclosure, a standard totally enclosed fan-cooled enclosure, or an explosion-proof TEFC enclosure. Whatever the horsepower, whatever the enclosure, whatever the application, one thing is sure... these compact, power packages get the job done. For all the reasons why, check with the Wagner Sales Engineer in the Wagner branch nearest you, or write us for Bulletin MU-249.

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Wagner Vertical Solid Shaft Motors provide the power for Smith & Loveless sewage pumping stations.



WMAI.



122

Along with outer space is still making

The T-J Spacemaker cylinder line is not now, nor ever has been, a probe into outer space. It is offered as a practically designed, research engineered and time tested product. Its Spacemaker feature (no tie-rods) and rugged construction gives greater strength, saves space and reduces costs in all power

drive applications. The Spacemaker is available in a complete range of bore sizes and strokes, air or hydraulic, and contains many plus features and extras as STANDARD . . . NO EXTRA COST! Write Tomkins-Johnson, 2425 W. Michigan Ave., Jackson, Mich. for Bulletin #155-4 and for full particulars, today.











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Selection of finest raw materials

Testing every step of the way

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OHIO WELDED PRESSURE TUBING

You can be sure — doubly sure — of utmost tubing dependability when you specify Ohio Welded Pressure Tubing — made by Ohio Seamless. First, Ohio works to accepted industry standards — ASTM, ASME, and similar Federal and military specifications covering welded pressure tubing. Second, Ohio Welded Pressure Tubing is produced under a continuous process of quality control — not just a final test inspection to cull questionable material.

Carefully selected prime raw material is slit, edged, shaped and electric resistance welded on the most versatile and modern equipment in operation. At each and every step of the way Ohio Welded Pressure Tubing is under the scrutiny of Ohio's master tubemakers... making control tests at frequent intervals... testing random samples from each production order far beyond the limits of the usage involved.

For critical pressure piping applications...for condensers, heat exchangers, boilers and superheaters—in the range of sizes from ½ to 7½" OD and wall thicknesses from .028 to .375"—mark your prints "Ohio Custom Made Welded Pressure Tubing." There is no equivalent.



Photographs show flare, flattening and crush tests performed continuously on every order. Non-destructive tests include air, water, magnetic, eddy current and visual inspection to insure 100% dependability.

Photomicrograph of polished and acidetched surface shows perfect microstructure of normalized Ohio Welded Pressure Tubing. Weld area running down the center is now indistinguishable and tube has become, in every sense, weldless.



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Representatives in principal cities. Check leading directories:
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Circle 289 on Page 19

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THE NEW BOWMAN CHAIN



- 58% stronger than equivalent sizes of commercial roller chains.
- Tested and proven to give greatly increased life.
- Works over standard cut tooth ASA sprockets.
- Permits space-saving machine design.

A new chain design made to solve your needs for improved service life. Let us show you the facts. For more information, write The Jeffrey Manufacturing Company, 798 North Fourth Street, Columbus 16, Ohio.

If it's conveyed, processed or mined, it's a job for Jeffrey.



How to select or design a pump for pressure lubrication

by E. H. Schanzlin

Chief Engineer, Tuthill Pump Company

Our headline is something of a misnomer . . . for designing a pump for pressure lubrication today would be as pointless as designing a dowel pin.

Instead, there's a simple and increasingly popular answer to this problem. Practically every important manufacturer of air conditioning or large air compressors... manufacturers of machine tools... dieselengines... plus hundreds of manufacturers of diversified industrial equipment from valve operators to giant gear boxes... have selected Tuthill internal gear pumps for this demanding application because of compact size, economical price, quiet operation... and, above all, for their dependability, proven in over thirty years of operation.

Internal Gear Operating Principles



Tuthill internal gear pumps have only two moving parts. The pumping principle is based on the use of a rotor, idler gear, and a crescent shaped partition cast integral with the cover.

Power applied to the rotor is transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the inside diameter of the rotor is sealed by the crescent.

As the pump starts, the teeth come out of mesh increasing the volume. This creates a vacuum, drawing the liquid into the pump through the suction port. The liquid fills the

THE CONTRACTOR OF STREET O

Tuthill model ORL pump provides pressure lubrication for Lodge & Shipley POWERTURN lathes. Mounted in headstock area, this reversing pump is driven by a reversing clutch shaft, provides positive reversing action. Ports remain constant without use of valves.

spaces between the teeth of the idler and the rotor, and is carried past the crescent partition to the pressure side of the pump. When the teeth mesh on the pressure side, the liquid is forced from the spaces and out through the discharge port.

Special Advantages of Reversing Pumps

Tuthill also offers a complete selection (375 models) of internal gear pumps with a special reversing feature. The unique construction of these units permits positive reversing action without the use of valves, and with the port positions remaining constant.

Reversing pumps are necessary when the lubrication pump must be driven by a reversing shaft, or when machinery must be shipped without knowing the ultimate direction of the driving unit.

A good example is shown above. A reversing pump is mounted directly on the reversing clutch shaft in the headstock area of Lodge & Shipley's POWERTURN lathes to provide dependable pressure lubri-

cation of these outstanding machine

Stripped or Cartridge Models

For extremely crowded applications, or extra economy, Tuthill also offers a complete selection of stripped and cartridge models, in which only the basic pumping elements are supplied for incorporation directly into your equipment. These units have been widely used to supply positive pressure lubrication and hydraulic power in many important applications.

Over 800 Models

Tuthill's complete selection of internal gear pumps includes over 800 different models from stock for capacities from ½ to 200 gpm; for pressures to 500 psi; and speeds to 3600 rpm. Specially designed housings, shaft extensions, relief valves and many other features can be developed by Tuthill engineers for specific applications.

Write for complete catalogue No. 100 . . . or send us drawings on your application so Tuthill's engineers can make specific suggestions.

Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1/3 to 200 gpm; for pressures to 1500 psi; speeds to 3600 rpm.



DESIGN

June 22, 1961



On Management's Ground

PROFESSIONAL people cherish the comfortable security they find among their own kind. It is disturbing to have to deal with nonprofessionals or, worse yet, with people of another profession.

The most critical stages of an engineer's career, however, come when he must step into the unfamiliar surroundings of the management profession. For instance, to get his ideas accepted he must face management on management's home ground.

Technical merits of his engineering ideas may mean little or nothing to management people. They couldn't understand them, and they couldn't care less. All of the engineer's carefully marshalled engineering arguments are lost unless he can also present the benefits in terms of management's own interests—mainly, will the new proposal make money?

There are other obstacles, as Eugene Raudsepp points out in his article overleaf. But they all point to the simple need for the engi-

neer to invade management's territory—to know what makes its people tick, to learn their particular jargon.

A visiting ball team doesn't play on the opponent's home ground without studying and understanding the peculiarities of the strange field. Common sense dictates equally careful preparation by the engineer.

Presentation of an idea to management need not be approached with trepidation. Of course, management people know all the angles of selling techniques, and they can spot a phony a mile off. So the engineer who has built his case in management's language can be confident if he also remembers John Ruskin's admonition: "He who has truth in his heart need never fear the want of persuasion on his tongue."

bolin barmilael

HOW TO SELL

A primary function of engineers is to generate new ideas. But this is not a limit to their job. Although usually untrained in the arts of persuasion, engineers must still convince the people who hold the purse strings. Here's how to sell ideas, and what to expect in the way of sales resistance.

EUGENE RAUDSEPP

Director of Psychological Research
Deutsch & Shea Inc.
New York

ILLIONS of dollars are lost to industry every year because many valuable ideas stay locked up in engineers' minds. They stay there because engineers have difficulty promoting or selling ideas to others. Frequently, the basis of this problem is fear of rebuff. This fear, in turn, may be based on past rejections, but it also can be a reluctance to face up to the enormous task of putting the idea into a salable prototype. Or it may be that the additional effort to convince others of the value of an

IDEAS

idea may seem much less important than having conceived the idea in the first place.

Experience in industry has shown that the major part in creative work lies in formulating, verifying, and polishing ideas so they can be sold to management. Putting an idea into salable shape forces an engineer to overcome a lot of personal obstacles and fears. It also requires sustained effort and persistence over a long period of time. It may, indeed, demand more work and preparation than did the origination of the idea. In addition, it requires a lot of courage,

imagination, initiative, resourcefulness, and staying power to prosecute a new idea and find acceptance for it. As Joseph G. Mason has pointed out:

In many cases, the person you are submitting your ideas to will not even realize that there was a need for such an idea. You may have to begin at the beginning and trace through the whole reasoning process that you yourself followed in arriving at this new idea of yours.

Lacking persuasive powers, many an engineer feels that it is not worth the trouble even to try to over-

Evaluating a New Idea

Before presenting an idea, evaluate it along these lines:

- How much time is needed to put the idea into shape so it can be presented to others?
- 2. How valuable will it be? What about its timeliness and practical aspects? What about the extent of improvement it promises over existing devices? What about its breadth of application?
- 3. What about its sales appeal? Does it fill a real need or does the need have to be created through promotional and advertising efforts? How ready is the market for it? Have the possible user criticisms or difficulties been foreseen?
- 4. What eventual savings will this new idea effect? What about the materials to be used in the production of this new device? Have the possible constructional, design, and manufacturing difficulties or objections been considered?

- 5. Is it compatible with other products the company produces?
- 6. Does the company have the necessary equipment to produce the item? What costs would be involved in getting the special equipment, if needed?
- 7. Has the operational soundness of the idea been reviewed and checked in all its ramifications? What about any possible technical faults or limitations of the idea?
- 8. Is it possible to work out several variants of the idea to afford those who will judge it a freedom of choice?
- Will position in the company reduce or enhance the acceptance of the idea? How will the proposal affect future personal status?
- 10. What comments do close associates have? Objections should be studied dispassionately and objectively. "Bugs" they find should be removed. If the idea still seems worthwhile, it is ready for presentation.

come the possible objections of others and convince them of the advantages of a new idea.

First failures at selling an idea need not, however, be fatal. The second or third idea might find the going easier, and as A. L. Simberg of AC Spark Plug has stated,

Thinking up ideas has other benefits for the individual than possible financial gain or extensive recognition in some form. Thinking up ideas on the job promotes interest in work; it increases job understanding; it is good mental exercise and self-training; it provides an opportunity to practice and demonstrate idea ability even though an idea may not be accepted.

For an engineer to present his ideas more effectively, he must understand the reasons for resistance to ideas or to change. Before taking appropriate action, an engineer should identify sources of resistance.

Overly Judicial Approach: Most people tend to be overly critical when evaluating a new idea. They can't think easily along unconventional paths. They often feel that when they review a proposal or a new idea, their task is to tear it to pieces, or show that the proposed idea would not work.

Judicial thinking is powerful because it is based on what is already established, accepted, or proved. It rests on precedent and facts—in short, on everything that is in the past tense. It can always marshal a mountain of arguments from the established order of things to show how and why a new idea won't work. The new idea requires risk-taking, imaginative acceptance, and willingness to gamble. It is therefore relatively easy for overly critical or skeptical people to find many disadvantages or faults in new ideas.

Threats to Security and Status: People may react negatively to a new idea because it is not their own. Supervisors, especially, are prone to this for they feel that their power and status are threatened if their underlings suggest new ideas. They feel that if changes should be suggested, then they should have thought of them in the first place.

Change is also fought because it might tumble an expert from his pinnacle. Dr. Elliott Dunlap Smith explains it this way:

The greater and more intricate the structure of thought involved, the greater the difficulty of change. With a man who for a long time has followed one angle of approach, a fundamentally new approach may even involve changing from an expert who is working in an area where he is highly skilled and completely at home into a novice who is feeling his way. Thus, the approach to the problem of drying ink through internal chemical reaction instead of mechanical drying meant that all the work on that problem which the mechanical engineer had done and the

Presenting

In many ways, the most crucial aspect of the entire creative process is in the presentation of a new idea. At this stage, many brilliant ideas die because of failure to communicate persuasively. For better chances of success, use these guides:

- Sell the immediate manager or supervisor first. In most companies, he is the key person. His backing will help sell the idea to higher management.
- If the idea must be presented to a group or a committee, try to sell the idea to one or two members of the group prior to the meeting. These individuals often appreciate this advance confidence, and may help if the going gets rough.
- Before actually presenting the new idea, give a short background history of the problem, and then proceed to solve it.
- 4. Don't get overly anxious about rejection because this will spoil the presentation. Be prepared to answer all possible questions, give all the data and facts pertaining to the idea, and what reasoning was used to arrive at the new idea.
- Presentation should be concise and directly to the point. Busy supervisors and managers may get impatient with longwinded preliminaries and side issues.
- 6. When the audience includes technically highly sophisticated people, the engineer has to include in his discussion all possible counterarguments to his idea. For sophisticated people, technical or otherwise, the prime requirement is that the presentation be thorough, and not necessarily brief.
- 7. Presentation of the new material should be delivered no faster than it can be understood and absorbed. Clear and lucid language within easy grasp of the listeners should be used. In regard to this, E. J. DeWitt, President of Wallace Supplies Mfg. Co. reports:

We have had tape recordings of engineers trying to tell management what would be management's gain if the engineers' recommendations were to be followed. Reruns of these tapes have been most instructive. Time after time, verbal impasses developed. Time after time, restudy showed a "bogging down" over a technical phrase in a layman's discussion.

a New Idea

Most people—engineers included—tend to talk with their everyday vocabularies. Unfortunately, the everyday vocabulary of the specializing engineer is not one with which most laymen will be comfortable.

8. Arguments to any possible objections or criticisms should be well prepared, but should not be used before they are actually needed. An argumentative approach in presentation creates the impression of unnecessary defensiveness. An overly argumentative approach may change completely the attitudes of the listeners. Dr. Paul R. Lawrence of Harvard University has pointed out:

A man who goes into this job with the conviction that people are going to resist any idea he presents with blind stubbornness is likely to find them responding just the way he thinks they will. The process is clear: Whenever he treats the people who are supposed to buy his ideas as if they were bullheaded, he changes the way they are used to being treated; and they will be bullheaded in resisting that changel

 Pay special attention to the practical details of an idea—how it can be executed and implemented. The advantages, as well as the costs and difficulties, should be pointed out. Chances of a new idea fade when it is presented in a purely technical or abstract way.

When selling an idea to management, it should be remembered that a strong dollars and cents orientation has to be met. Sales appeal and profit potentials should be definitely demonstrated, and the presentation should include plenty of "benefits-to-us" statements, not solely "how-it-works" discussion. As E. J. DeWitt has put it:

All too often those who must evaluate the engineer's ideas are "money-minded." They, too, have their comfortable trade talk. And it is apt to be the jargon of the financial world or the world of accounting. In this case the engineer is doubly burdened. He not only must untrack himself from his comfortable paths, but he would gain much if he could rephrase his values into their language.

The engineer must be prepared for all questions concerning the implementation

and manufacturing of the idea. He must know what competition is doing in this area. He must point out what real need his idea fills—what concrete benefits it has.

- Augment the verbal description with suitable sketches, charts, and models. Mere verbal description averly taxes attention.
- 11. Overselling should be avoided. While enthusiasm can be contagious, a superabundance of it, especially at the beginning of the presentation when the full story still has to be told, will put people on the defensive.
- 12. When arguments are raised against an idea, don't attempt an immediate refutation unless the refutation is absolutely convincing. Often, it is more advisable to follow the unrefuted argument with another very positive argument in the idea's favor. Later, when a more positive tone of the session has been built up again, the unrefuted argument may be taken up and neutralized.
- If the idea is too radical or too big, present it piecemeal, in logical sequence.
- 14. Don't assume an air of superiority when presenting the idea. This may make the other persons in the group feel small or inferior and thus evoke a negative climate.
- Try to get management approval for an investigation of the problem. If approval is granted, half the selling job is done.
- 16. If not sure about the accuracy of statements when answering questions, don't try to hide this fact but agree to find the answers and forward them later.
- Find out as much as possible about the people to whom the idea will be presented—their temperaments, attitudes, idiosyncrasies, and preferences.
- 18. Learn to write effective reports. No matter how brilliant the idea, inability to describe it effectively in written form may reduce its chances for acceptance.
- Leave copies of the report with the people who listened to the presentation.
- 20. At the end of the presentation, sum up the salient points, the anticipated benefits and advantages of the idea, the need that exists or can be elicited for the idea, and why the idea should be implemented forthwith.

ability which it had given him were made obsolete. The problem was no longer even in his department.

John D. Staley has summed up the threat to security that new ideas or changes bring this way:

When a change occurs, it may appear as a threat to a person's security, and therefore he fears the change. In an industrial or business situation, people fear they may lose . . .: Earnings (all or part), job, friends, status, recognition, skill, chance for advancement, favorable working conditions, rights of office, easy work, ability, habit.

Conservatism: Unwillingness to make or accept changes and ideas stems frequently from the strong preference that some supervisors and management have for order and the status quo. They tend to react with conservative defensiveness and trigger-ready rejection to ideas that do not fit into an established pattern. They suffer from "the hardening of categories," which permits the acceptance of ideas and information that can be easily classified and filed into existing categories. New ideas and information for which there are no existing slots are generally rejected. The rejection mechanism used is the negative and critical approach or an outright ignoring of the new idea.

Transgression into Private Domains: Some supervisors and managers feel that new ideas, especially when they are in a different area from the originator's specialization, attempt to encroach upon another person's province. Each person's responsibility in companies is, as a rule, carefully defined and people come to regard these responsibilities as their private domains. These barriers, in addition to killing off a lot of valuable ideas, are also responsible for preventing the free flow of communication between functional groups in industrial organizations.

Security of the Familiar: Time-tested methods and procedures give people a feeling of anchorage. With the passage of time, many supervisors and managers, as well as engineers, tend to become more and more habit-prone. They build up comfortable systems or channels which they can take for granted, and into which their need for stability and security can easily flow and solidify.

If at times something really new wells forth in their departments, the conflict between the old and the new often ends with the victory of the conservative attitude. "After all," they think, "why should we disturb things as they are set up, especially if they seem to work satisfactorily?" They may also feel that changes will lower the value of what exists. Or the reasoning goes, "We have enough problems as it is. Why add problems we might not even be able to cope with?" Clearly, accepting a radical change or new idea means more headaches, work, and responsibilities.

Counter to this attitude, there are managements and companies who encourage new ideas and bold creative advances, and thus move ahead by leaps and bounds. When management fears the novel because it might unbalance its reassuring expectations, the company develops into a copier or seeks relatively small, predictable, and orderly improvements. This tendency toward security and caution may stunt the creative growth and progress of a company to a degree where it ultimately fails to cope with competition.

Fear of Failure: In the success-oriented career of supervision and management, failure looms large. Yet failure is part and parcel of implementing a new creative idea.

The specter of failure casts such a fearful shadow over management mainly because of the heavy responsibility for accurate judgment they have assumed, and the pride they take in their ability to plan and predict successfully. They fear the ridicule and criticism which usually attends failure. Rare indeed is the attitude reported by William Wilson of Kimberly-Clark Corp.:

One way we cope with the problem of fear of failure is by developing an attitude that there is no such thing as failure, because seeming failure is a learning process. The only real failure is not to have learned something from our mistakes. The even greater failure is not to have tried in the first place.

There has always been a resistance to accepting new ideas, no matter what the field. Even as prolific an inventor as Thomas A. Edison once stated:

Society is never prepared to receive any inventions. Every new thing is resisted, and it takes years for the inventor to get people to listen to him and years more before it can be introduced.

Although the situation since Edison's time has somewhat improved, the task of convincing others of the value of one's idea is still stupendous.

Realistic Resistance to Change: There may be some very realistic and logical reasons for the rejection of some new ideas. Here are several:

Sometimes the number and extent of current projects is such that undertaking work on new ideas might seriously disrupt work the company is previously committed to. In this case, it is obvious that presenting a new idea should be delayed.

Creative ideas in engineering sometimes bear striking resemblances to previously submitted ideas. Sometimes the engineer does not know that an idea he has worked long and hard over is already in the development stage. This should not disappoint the originator unduly, for it is a clear proof that he can produce practical and salable new ideas. The next time he may come up with something original.

Occasionally a good new idea would be so costly to develop that it would be impractical from the company's standpoint.

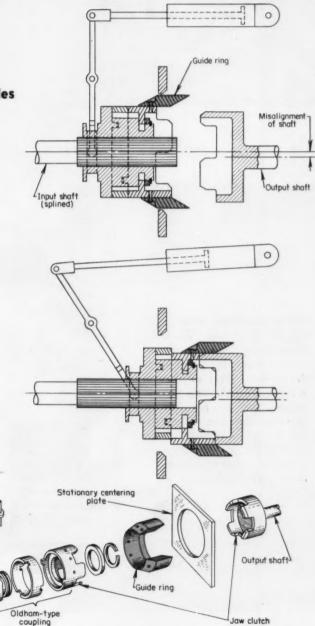
Sometimes a new idea concerns only a small part of a complicated equipment that is already scheduled for a complete change. The proposed partial change may not fit in with over-all plans.

scanning the field for ideas

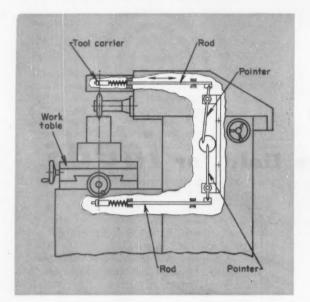
Double-chamfered ring guides

Hydraulic actuato

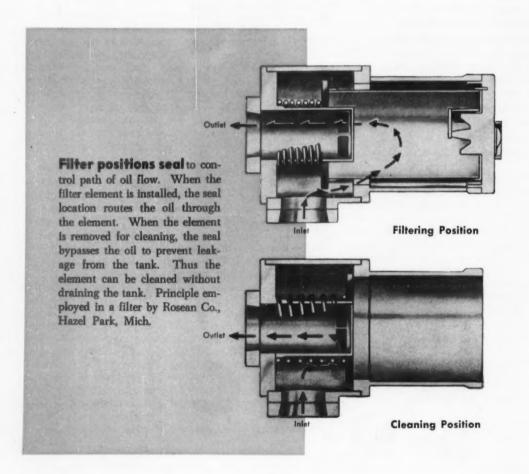
the two halves of a self-aligning jaw clutch during engagement. An Oldham-type coupling in the clutch assembly accepts shaft misalignment. When the clutch is disengaged, the second chamfer of the guide ring centers the coupling for the next engagement. Principle reported by I. M. Abeles, used in a disconnect clutch of a shipboard missile handling system by General Electric Co., Pittsfield, Mass.

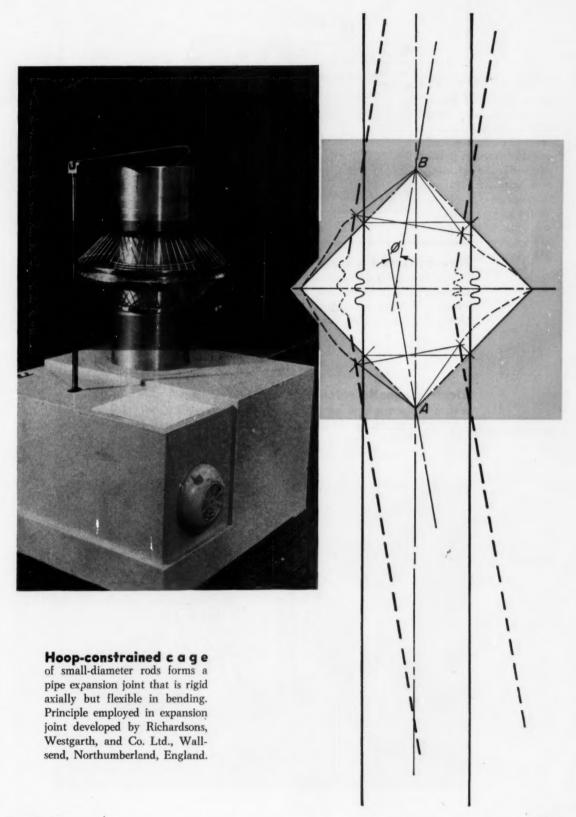


SCANNING THE FIELD FOR IDEAS

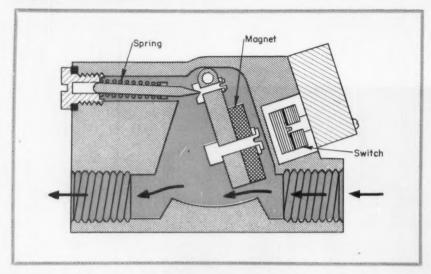


Matched pointers indicate alignment of tool carrier and the work table of a precision machine tool. Any misalignment produced by subsequent temperature changes of machine parts is indicated by mismatched pointers. Principle employed in machine tool by M. Hensoldt and Soehne AG, Wetzlar, Germany.



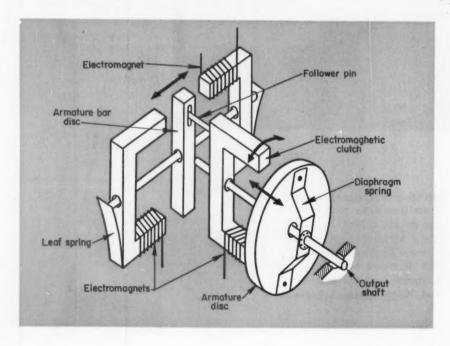


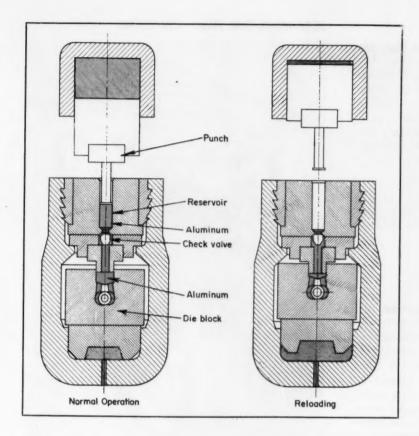
SCANNING THE FIELD FOR IDEAS



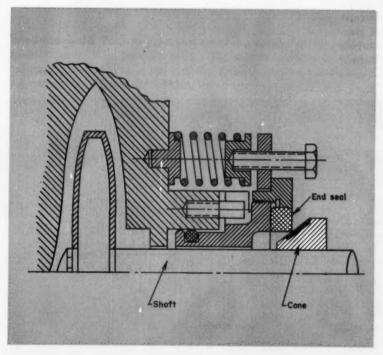
Flow-deflected magnet controls the operation of a safety cut-off switch. Normal flow holds the hinge-mounted magnet away from the switch. When flow decreases below a preset level, the pring-loaded arm swings toward the switch, which is actuated by magnet. Principle employed in a liquid-flow switch by Henry G. Dietz Co. Inc., Long Island City, N. Y.

Electromagnetic ratchet provides low-speed output drive. Reciprocating motion of the armature bar oscillates the electromagnetic clutch. The armature disc is attracted during one half of each oscillation and released during the return. Intermittent drive principle employed in a step motor designed by Telefunken GmbH, Backnang/Wurtt, Germany.





Hydraulically positioned block moves die toward punch to maintain extrusion pressure during reloading of extrusionmaterial reservoir with aluminum billets. Thus, the output of the press is a steady flow, even though it is loaded in batches. Principle employed in cable-coating extrusion press by Siemens-Schuckertwerke AG, Erlangen, Germany.



Tapered sealing surface

of a cone rotating with the shaft permits easy adjustment to compensate for wear of the end seal. The seal is in two halves to facilitate replacement. Principle employed in a sealing gland by Ronald Trist and Co. Ltd., Slough, England.

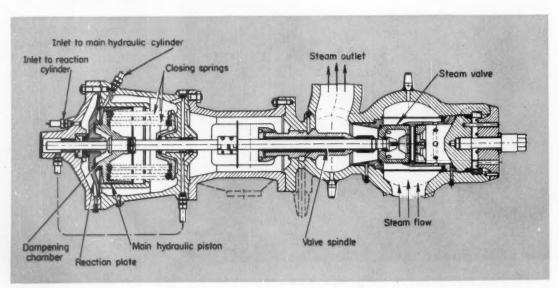
SCANNING THE FIELD FOR IDEAS

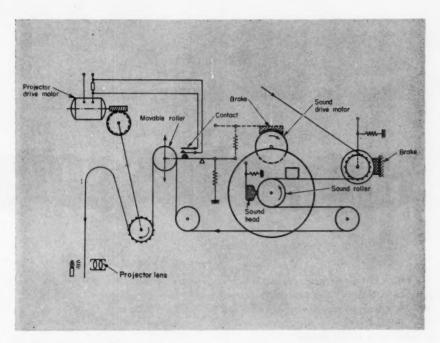
Bearings replace king pin in a caster pivot assembly. Upper ring of larger balls support normal downward load. Lower ring of smaller balls restrains the caster wheel when the load is removed. Support principle employed in a caster by Fairbanks Co., New York, N. Y.



Pressurized reaction plate

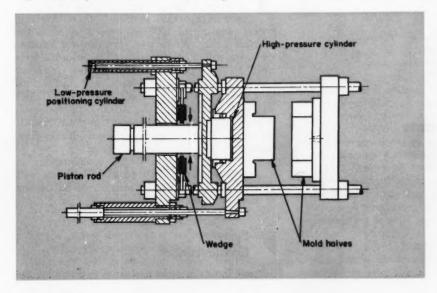
doubles as a dump valve to provide a fail-safe hydraulic actuator for a steam-turbine control valve. When the main hydraulic cylinder and the reaction cylinder are pressurized, the steam-control valve is held open against steam pressure. To close the steam valve, the hydraulic pressure in the reaction chamber is released. The reaction member unseats to provide a large annular escape passage for the main hydraulic cylinder pressure. Reaction plate principle employed in a turbine by Elektricitaets - Gesellschaft, Berlin, Germany.





Roller senses length of film loop to maintain exact length necessary for synchronization of sound and picture in a movie projector. Any change in the length of the film between the sound head and the projector lens displaces the spring-loaded roller and actuates a speed-regulating contact in the projector-motor circuit. Principle employed in a movie projector by Eugen Bauer GmbH, Stuttgart, Germany.

Wedges hold rod to provide a reaction member for the high-pressure hydraulic squeeze of an injection mold. The wedges are released to permit piston rod travel for positioning at low pressure. Principle employed in an injection molding machine by A. Triulzi SAS, Milan, Italy.



Design Considerations in

HIGH-PRESSURE

Selection of system pressures can be vexing—many factors come into play. Relative cost, availability of components, heat generation and dissipation, pressure losses, leakage, and safety, must all be carefully weighed. Here is a guide for making a comparative analysis to arrive at a sound decision.

RUSS HENKE

Director of Research Racine Hydraulics & Machinery Inc. Racine, Wis. RANSMISSION of more power in a smaller envelope is the primary advantage of a high-pressure hydraulic system. Not too long ago, system pressures of 1000 psi were accepted as the practical limit. While most machine-tool applications are still in this range, other industrial systems, such as plastic injection-molding machines and fabrication machinery, are now at the 3000 psi level. Many press circuits operate in the 5000-6000 psi range, with some at the 10,000-15,000 psi level. Present mobile equipment operates in the 1000-2000 psi range. Current trends are toward higher pressures—into the 5000-6000 psi range.

This article discusses design considerations in industrial systems of 5000 psi and higher, as well as commercially available components to operate at these pressures.



System Considerations

Many factors must be evaluated to determine the

HYDRAULICS

- Systems
- Components
- Economics

desirability of using a high-pressure hydraulic system. Included are:

- 1. Space requirements.
- 2. Cost factors.
- 3. Circuit complexity: Available components, cost of components, and feasibility of installation.
- Design: Safety considerations, compressibility factors, heat generation and dissipation, flow rates, pressure losses, leakage factors, efficiency.

The starting point in any fluid-power circuit analysis is the power to be transmitted.

P = K p Q

where P = power; K = constant; p = pressure; and Q = flow rate.

Thus, these basic principles:

- 1. The higher the pressure, the lower the flow rate required for constant power.
- The higher the pressure, the higher the power produced for a constant flow rate.

However, this relationship might lead to the erroneous decision to use the highest pressure attainable, to reduce circuit components to a minimum size for a given power transmission. But in practice, there are several limitations that must be considered.

Safety: Generally speaking, a hydraulic system bled of trapped air is relatively free of releasable energy. A leak or a parts failure only wets the immediate area with hydraulic fluid.

However, any trapped air will be compressed to the same pressure as the hydraulic fluid. This situation can represent a serious safety hazard, because failure of the container may produce an explosive release of energy.

Less obvious considerations are the storing of energy in the elastic members of the system, and the compression of the fluid itself. These problems are encountered in the circuits of draw presses, shears, and plastic-molding machines. Such parts as tie rods act as giant springs, storing energy when stretched. Therefore, control valves must be provided for gradual decompression to release these pent-up forces, since sudden release could deliver a damaging blow to the machine.

Fluid Compressibility: Generally, hydraulic oil is considered to compress 0.5 per cent volumetrically per 1000 psi of pressure. In low pressure circuits compressibility produces only a heating effect.

However, in press circuits the decompression problem is encountered. In precise control circuits, compressibility can affect the time response or stability of the system.

Heat: In any hydraulic system, heat is generated as a function of work done on and by the fluid. Adiabatic compression of the fluid in the pump, fluid friction effects, turbulence, and throttling, all contribute to the generation of heat. Much of this heat energy is conducted to component housings and piping walls, and radiated to the surrounding atmosphere. The reservoir also acts as a heat

sink to provide a major cooling area. However, if radiant dissipation is insufficient, a cooler will be required to maintain the fluid temperature at a suitable level.

For comparable rates of power transmission, less heat is normally produced in a high-pressure system than in a low-pressure one, because of reduced flow rates. However, the heat generated will be a function of the over-all circuit design.

Flow Rates: An increase in operating pressure reduces the flow rate required for a given hydraulic power output. One advantage of the reduced flow rate is the reduced pressure drop through orifices and lines. An additional advantage is that the pressure loss is a smaller proportion of the total. Thus, more pressure is available downstream to perform useful work.

The main advantage of reduced flow rates, how-

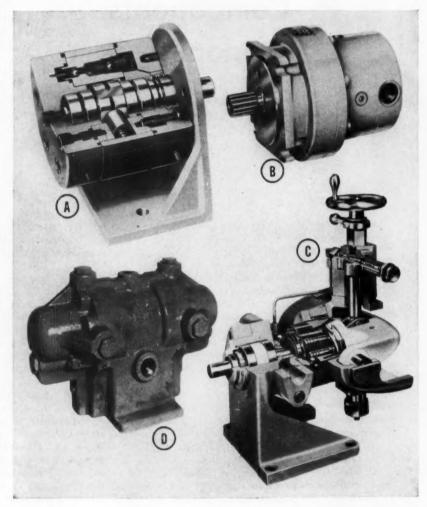
Pumps for High-Pressure Industrial Applications

Radial piston pump rated at 10,000 psi maximum pressure. Models are available with displacements from 0.32 to 11 gpm. Individual piston discharges may be combined to give maximum displacement, or they may be isolated to give split outputs. For example, in a six piston pump, all pistons are used to give maximum displacement for rapid traverse. Then, five pistons are unloaded and one provides high-pressure hold.

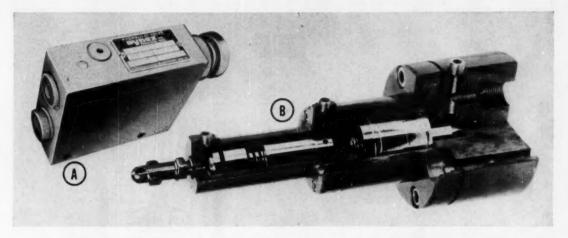
B Axial piston pump of nominal 6000 psi maximum pressure. This type by Dynex Inc., is available in ratings from 1.8 to 11 gpm. Pump output may be routed to feed two or more circuits, or combined into one.

Variable or fixed-displacement, axial-piston pump, rated at 5000 psi maximum pressure. Models are available in 3 to 35 gpm range. This Denison pump is the rotating barrel, variable swash-plate angle type.

Pressure-booster pump rated at 5000 psi. This type operates on a differential area principle. Low pressure, acting on a piston of relatively large area, drives a smallarea piston. Output pressure equais input pressure times the area ratio. Some low displacement models are available with ratings up to 30,000 psi.



Pressure-Control Valves for High-Pressure Industrial Applications



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- A Typical relief valve by Dynex Inc. in the 5000-6000 psi range.
- B Two-stage relief valve rated at 30 gpm, 10,000 psi maximum setting. This type valve provides two pressure controls. Pilot pressure admitted through the

upper port forces the pilot ram downward, compressing the control spring for one setting. When pilot pressure is released, the spring alone controls the setting. Valve also can be programmed as unloading valve by connecting an external vent line to middle port. When ported to exhaust, the main poppet can move upward to unload the circuit.

ever, is the reduction in the size and cost of components.

Leakage: This, traditionally, has been one of the main trouble spots in hydraulic systems. Recent improvements in seals and packings have helped control this problem. Careful system design can overcome the increased leakage tendencies inherent in high-pressure systems.

Efficiency: Low-pressure and high-pressure systems should be compared on an equivalent-power basis. On this basis, the high-pressure system generally will be more efficient. Equivalent efficiencies should be compared only for reasonably similar equipment. For example, a tractor power system should not be compared with a servocontrol system.

Component Considerations

In general, the dividing line, cost-wise, between low-pressure and high-pressure systems is about 20-25 hp. Below this level, other factors besides component cost usually overcome the high-pressure advantages. Above this level, high-pressure systems can be competitive. However, a thorough engineering analysis is required in each specific situation.

Pumps: This component, the heart of any hydraulic system, usually determines the service life of the circuit. Seldom do any other circuit components require more maintenance.

In selecting a pump, the choice between high and low pressure must be made on a power, rather than a displacement basis. Generally, pump costs will be:

Gear	pumps	
Vane	pumps	\$1.50 to \$3.50 per hp
Piston	pumps	\$5 to \$10 per hp

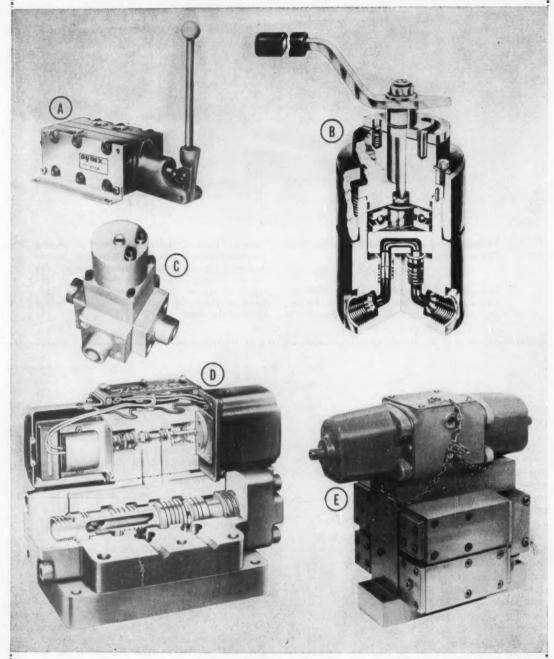
For pressures of 5000 psi or more, piston-type pumps are used almost exclusively.

Actuators: Actuators for high-pressure circuits are usually either cylinders or fluid motors. The standard for comparing high and low-pressure cylinders is thrust—the product of pressure and effective area. Structural, in addition to hydraulic, factors must be considered. For example, the piston rod in a 1 sq in. cylinder would not be strong enough to withstand a 10,000 lb thrust through any appreciable stroke. Most high-pressure motors are structurally similar to the corresponding pump types and are built by the same manufacturers.

Valves: These are required for direction and flow control of the pump output. Only recently have improvements in valve design made practical the control of high pressures.

Presently, direction-control valves are available

Direction-Control Valves for High-Pressure Industrial Applications



- A Typical slide valve rated to 6000 psi. Capacities of this Dynex valve range to 10 gpm. Manual and solenoid operators are available.
- B Shear-seal valve available in pressure ratings to 10,000 psi. Manual and solenoid-pilot controlled operators are available for standard pipe sizes from 1/4 to 1 in. Fluid-capacity ratings are 5.8 to 12 gpm.
- Spool valve rated at 5000 psi. This Denison valve is available in sizes from 1/4 to 11/2 in. pipe sizes with manual, electric, or pilot operation.
- Typical four-way ball valve with rotary hydraulic actuator.
- Four-way direction control valve rated at 10,000 psi. This type is solenoid controlled and manifold pilot-check operated.

Table 1-Manufacturers of Industrial High-Pressure Components

(All values in psi)

Manufacturer	Pumps and Actuators		Control Valves	
		Direction	Pressure	Flov
American Engineering Co.	5,000		***	***
Barksdale Valves	• • • •	10,000	****	***
Circle Seal Products Co.	****	3,000		3,000
Denison Engr. Div.,				
American Brake Shoe Co.	5,000	5,000	5,000	5,000
Dynex Inc.	6,000	6,000	6,000	6,000
Fluid Controls Inc.	****	****	****	3,000
Greer Hydraulics Inc.	****	****	****	. 3,000
The Oilgear Co.	5,000	5,000	5,000	***
Payne Mfg. Co. Inc.	****	****	5,000	***
Pneudraulics Inc.	****	****	5,000	***
Racine Hydraulics & Machinery Inc.	10,000	10,000	10,000	
Republic Mfg. Co.	****	3,000	5,000	3,000
Vickers Inc., Machinery Hydraulics Div.	5,000		****	***
Waterman Hydraulic Corp.		****		5,000

for these pressure ranges:

Spool valves	3,000 psi
Slide valves and ball	6,000 psi
Poppet and shear seal	10,000 psi

Typical cost ranges are:

Spool and slide valves	\$1 to \$2 per hp
Poppet valves	\$3 per hp

In addition to direction and flow control, pressure-relief valves must be provided for control of

system pressure.

Manufacturers of industrial pumps and valves are listed in Table 1.

Economic Considerations

Cost should be studied carefully when considering the choice of system pressure. The price of major components alone will not tell the story. Fre-

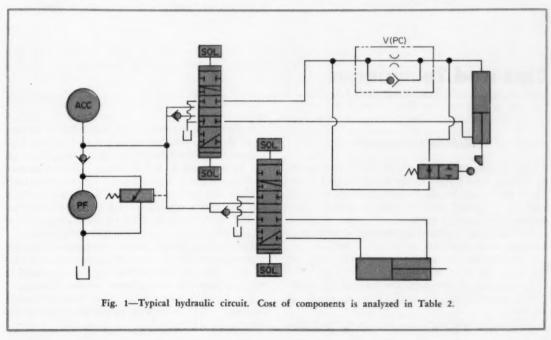


Table 2—Comparative Cost Analysis

Component	Component		Cost			st
	1000 pai	6000 psi	(Dol 1000 psi	lars) 6000 pei	(per cent	of total) 6000 ps
	1000 pm	0000 psi	1000 per	6000 per	1000 pm	6000 pa
Pump	60 gpm	10 gpm	178	423	5.6	22.7
Accumulator	2080 cu in.	226 cu in.	252	94	8.0	5.0
Four-way valves	60 gpm	10 gpm	372	296	11.8	15.8
Valve	1 1/4 in.	1/2 in.	87	66	2.8	3.5
Flow control valve	60 gpm	10 gpm	373	275	11.8	14.8
Cylinder	5% ID	2¼ ID	163	123	5.1	6.6
Cylinder	11 ID	4% ID	862	189	27.2	10.0
Unloading valve	1 1/4 in.	36 in.	84	58	2.7	3.1
Check valve	1 1/4 in.	1/2 in.	90	22	2.8	1.2
Fittings	24—1 ½ in. 8—1 ½ in. 2—3 in.	24—% in. 8—% in. 2—1% in.	286	121	9.1	6.5
Hose	11/4 in.	1/4 in.	26	20	0.8	1.1
Tubing	1 1/4 in.	61 % in.	31	27	1.0	1.4
Reservoir and filter	80 gal.	20 gal.	241	136	7.6	7.3
Dfl	150 gal.	25 gal.	117	19	3.7	1.0
Total			3162	1869	100	100

quently, cost analysis consists, incorrectly, of comparing pump, valve, and cylinder prices without considering auxiliaries.

Table 2 shows the comparative costs for a typical circuit, Fig. 1, and illustrates important factors. For instance, the high-pressure pump costs $2\frac{1}{2}$ times as much as the low-pressure pump. This relationship is reversed in the case of valves, however, with low-pressure units costing $1\frac{1}{2}$ times as much as high-pressure components. The cost ratio is even more marked when considering cylinders.

It is significant that cost of oil in the low-pressure system is greater than cost of the two-way valve, the unloading valve, check valve, or the combined cost of hose and tubing. It is not very much below the cost of the small cylinder. Yet, the cost of system oil is often completely ignored.

Consider the cost of fittings. Many times these are treated as incidental items with their cost only roughly estimated. Yet the analysis shows them to be the fourth most costly item, exceeding the cost of the accumulator, two-way valve, 5½-in. cylinder, unloading valve, check valve, or reservoir and filter.

ACKNOWLEDGEMENT

The author acknowledges with appreciation the co-operation of Mr. Wesley Master in the preparation of Table 2.

Tips and Techniques

Slide-Rule Accuracy

Certain slide rules, such as the Post Versalog and the Pickett log-log have extended square-root scales. These scales can be use for mutiplication, and will yield much greater accuracy than is available from conventional C and D scales.

Multiplication is carried out in the following way, assuming scale markings as on the Post rule:

1. Set the hairline at the multiplicand value on the R₁ or R₂ scale, whichever is best suited.

2. Move the CI scale until the value of the multiplier is aligned with the multiplicand on the R_1 or R_2 scale.

3 Bring the hairline to the value of the multiplier

on the C scale.

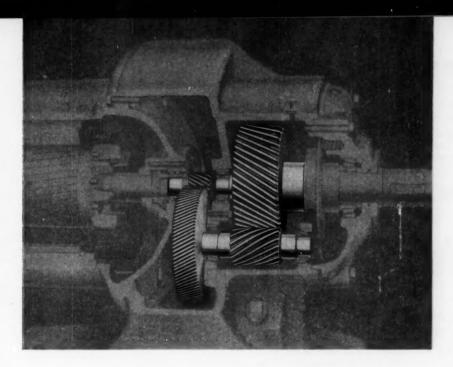
4. Read the answer under the hairline on the R_1 or R_2 scale, whichever was not used in Step 1.

EXAMPLE: Multiply 4.97 x 32.7. Calculation on the conventional C and D scales yields an answer of 162.6 or 162.7, where the last figure is estimated.

Move the hairline to 4.97 on the R_2 scale. With this value, line up 32.7 on CI. Bring the hairline to 32.7 on the C scale. Read on the R_1 scale, 4.97 x 32.7 = 162.5.

For division, simply reverse the process: Set the numerator on the R scale, the denominator on the C scale, and read the answer on the remaining R scale, opposite the denominator on the CI scale.

The folded scales, CF and CIF, may be used if necessary. The process is identical. — George N. Varga, Livingston, N. J.



Reverted Gear Trains

. . . a simple, straightforward method of determining the number of teeth needed to get exact ratios

ARNE BENSON

Staff Consultant Sanders Associates Inc. Nashua, N. H.

B ASICALLY, a reverted gear train consists of two or more gear pairs mounted on parallel axes so that input and output shafts are along the same line. Reverted trains are widely used because of their simplicity, compactness, and economy of manufacture.

Possibly the oldest—and smallest—application of the reverted gear train is found in watches and clocks. Reverted trains are also used in the back gears of lathes, in servomotor gearheads, and in counters, twist-drill flute-grinding machines, and coil winders. In a larger sense, the reverted train is the basic building block of parallel-axis epicyclic gear systems

Advantages of reverted gear trains are many: Compactness; minimum machining; minimum number of gears and bearings; coaxial input and output; same direction of motion of input and output.

Analysis is elementary. As with any simple gear train, train ratio R = mn/pq, where m and n = number of teeth in driver gears; p and q = number of teeth in driven gears.

Synthesizing a reverted train, however, can be difficult. Whereas the analysis of an existing reverted train proceeds from known pairs of gears in which the first and last gears of the train are coaxial, synthesizing such a train requires finding two or more pairs of gears that simultaneously satisfy overall train-ratio and coaxiality requirements.

Customary methods sometimes sacrifice exactitude of train ratio, or use nonstandard-pitch gears to achieve coaxiality. If an approximate ratio is acceptable, selection of gear-pairs is easy. However, some applications, such as instrument trains, need exact transmission of motion, and approximate ratios cannot be tolerated. Nonstandard pitches may be acceptable when quantities justify special cutter costs.

Basic Considerations

In practical design problems there are many combinations of conditions on tooth numbers, tooth sums, and ratios. These limit the range of useful solutions. One approach is to generate a large number of solutions by applying the Fundamental Theorem that follows, then to select the solution that satisfies the practical problem conditions.

General Case: For a two-mesh reverted train of external spur gears with identical pitch, the problem reduces to solving:

$$\left(\frac{m}{p}\right)\left(\frac{n}{q}\right) = R = \frac{tN}{tD} \tag{1}$$

$$m+p=n+q=\sigma \tag{2}$$

where m, n, p, q are acceptable tooth numbers for a given train ratio R and o is the tooth sum across each mesh. Tooth sum o may be specified or arbitrary, depending on the application.

Theorem I--Fundamental Theorem: To find positive integers m, n, p, and q for a given rational number R and arbitrary tooth sum o such that Equations 1 and 2 are satisfied, select integers a, b, c, and d so that ab =tN and cd = tD, where t is any number 1, 2, 3, etc. Then, the working equations for finding m, n, p, and q from a, b, c, d, and t are

$$m = a(b+d)/G$$
 $p = c(b+d)/G$ $n = b(a+c)/G$ $q = d(a+c)/G$

where G is the greatest common divisor of the numerators. Any set of four values, m, n, p, q, is a primitive solution. In theory, a given R has any number of primitive solutions.

In resolving a number like tN into a product of two integers a and b, a table of numbers and factors is helpful, particularly if numbers are large. When a tN number is composed of several prime factors, the factors can be combined in any order in choosing values of a and b.

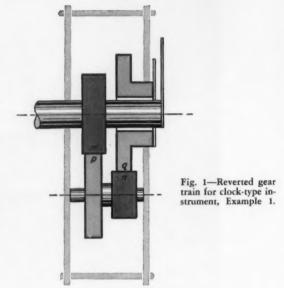
Theorem II: Tooth sum o for a particular solution is the least common multiple of (a + c) and (b + d), where ab = tN and cd = tD as in Theorem I.

These two theorems are sufficient to solve most reverted gear train problems. A few minutes spent in generating solutions for a chosen ratio demonstrates the power and prolific character of the method.

Example 1: Find a reverted gear train to connect the hands of a clock-type counter with a 1:10 ratio, Fig. 1. Use identical pitch and the smallest prac-

Nomenclature

- a, b = Positive integers, whose product is proportional to numerator of train ratio R
- c, d = Positive integers, whose product is proportional to denominator of train ratio R
 - D = Denominator of train ratio
 - G = Greatest common divisor
- H = Center distance, in.
- m, n = Number of teeth in driving gears
 - N = Numerator of train ratio
 - P = Diametral pitch, in.-1
- p, q = Number of teeth in driven gears
 - R = Train ratio
 - = mn/pq = N/D
 - $\sigma = Tooth sum$



tical center distance between gears, without modifying the gears. Requirements are: Pressure angle = 20 deg; minimum tooth sum = 36; minimum number of teeth in any gear = 12.

From this, (m/p)(n/q) = N/D = 1/10; m + p= $n + q = \sigma$; $\sigma \ge 36$; m, n, p, $q \ge 12$. From Theorem I, with t = 1,

$$\left[\frac{1(1+5)}{2(1+5)} \right] \left[\frac{1(1+2)}{5(1+2)} \right] = \left(\frac{6}{12} \right) \left(\frac{3}{15} \right)$$

$$= \left(\frac{2}{4} \right) \left(\frac{1}{5} \right) ; \sigma = 6$$

$$\left[\frac{1(1+10)}{1(1+10)} \right] \left[\frac{1(1+1)}{10(1+1)} \right] = \left(\frac{11}{11} \right) \left(\frac{2}{20} \right) ;$$

$$\sigma = 22$$

With t = 2, and ignoring the solutions that re-

duce to those for
$$t = 1$$
,
$$\left[\frac{1(2+1)}{20(2+1)} \right] \left[\frac{2(1+20)}{1(1+20)} \right] = \left(\frac{3}{60} \right) \left(\frac{42}{21} \right)$$

$$= \left(\frac{1}{20} \right) \left(\frac{14}{7} \right); \sigma = 21$$

$$\left[\frac{1(2+5)}{4(2+5)} \right] \left[\frac{2(1+4)}{5(1+4)} \right] = \left(\frac{7}{28} \right) \left(\frac{10}{25} \right);$$

Similarly, for t = 3,

$$\left[\begin{array}{c} \frac{1(3+1)}{30(3+1)} \right] \left[\begin{array}{c} \frac{3(1+30)}{1(1+30)} \\ \frac{1}{30} \end{array} \right] = \left(\begin{array}{c} \frac{4}{120} \right) \left(\begin{array}{c} \frac{93}{31} \end{array} \right);$$

$$\left[\begin{array}{c} \frac{1(3+2)}{15(3+2)} \end{array} \right] \left[\begin{array}{c} \frac{3(1+15)}{2(1+15)} \\ \frac{1}{30} \end{array} \right] = \left(\begin{array}{c} \frac{5}{75} \end{array} \right) \left(\begin{array}{c} \frac{48}{32} \end{array} \right);$$

$$\left[\begin{array}{c} \frac{1(3+5)}{6(3+5)} \end{array} \right] \left[\begin{array}{c} \frac{3(1+6)}{5(1+6)} \\ \frac{1}{30} \end{array} \right] = \left(\begin{array}{c} \frac{8}{48} \end{array} \right) \left(\begin{array}{c} \frac{21}{35} \end{array} \right);$$

Three solutions, corresponding to $\sigma = 6$, 35, and 56, appear promising. When these are multiplied by a suitable constant, they yield:

$$\left(\begin{array}{c} \frac{2}{4} \end{array}\right) \left(\begin{array}{c} \frac{1}{5} \end{array}\right) \dots \left(\begin{array}{c} \frac{24}{48} \end{array}\right) \left(\begin{array}{c} \frac{12}{60} \end{array}\right) \; ; \; \sigma = 72$$

$$\left(\begin{array}{c} \frac{7}{28} \end{array}\right) \left(\begin{array}{c} \frac{10}{25} \end{array}\right) \dots \left(\begin{array}{c} \frac{14}{56} \end{array}\right) \left(\begin{array}{c} \frac{20}{50} \end{array}\right) \; ; \; \sigma = 70$$

$$\left(\begin{array}{c} \frac{8}{48} \end{array}\right) \left(\begin{array}{c} \frac{21}{35} \end{array}\right) \dots \left(\begin{array}{c} \frac{16}{96} \end{array}\right) \left(\begin{array}{c} \frac{42}{70} \end{array}\right) \; ; \; \sigma = 112$$

The second of these solutions satisfies the problem requirements.

Example 2: Investigate the possibility of placing a reverted train on 5-in. centers with a tolerance of $\pm \frac{1}{2}$ in. Diametral pitch is 10 and the required ratio is 17.5:1.

Theorem II permits direct computation of tooth sum σ . Train ratio R=N/D=35/2. Because of center-distance tolerance and specified pitch, tooth sum σ must be between 90 and 110.

Form all factors (a)(b) = N = 35 and (c)(d) = D = 2. Combine the sets (a)(b) and (c)(d) in all possible ways to get the least common multiple of the terms (a + c) and (b + d).

If necessary, repeat for t=2; that is, N/D=70/4, etc. For each value of t, omit those combinations in which a and b have a common factor or where c and d have a common factor. These would reduce to a solution previously found for a smaller value of t. In choosing values of a, b, c, and d, it is most practical to start with values that make (ad-bc) a minimum, since this results in a minimum difference between the number of teeth in the driving gears. Assume t=1. For tN=35, (a)(b)=(1)(35) or (5)(7). For tD=2, (c)(d)=(1)(2). Then, for various combinations of (a+c) and (b+d), the following values of σ can be determined:

The third of these possible values, $\sigma = 18$, may yield a practical solution if multiplied by 6 to give a tooth sum of 108. Solving for tooth numbers, Theorem I:

$$\begin{bmatrix} \frac{a(b+d)}{c(b+d)} \end{bmatrix} \begin{bmatrix} \frac{b(a+c)}{d(a+c)} \end{bmatrix}$$

$$= \begin{bmatrix} \frac{5(7+2)}{1(7+2)} \end{bmatrix} \begin{bmatrix} \frac{7(5+1)}{2(5+1)} \end{bmatrix}$$

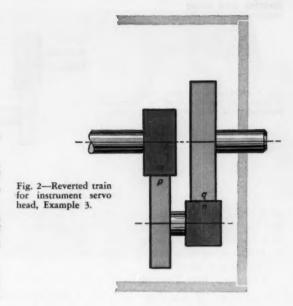
$$= \left(\frac{45}{9}\right) \left(\frac{42}{12}\right)$$

This gives the primitive solution (15/3)(14/4) = 35/2, and $\sigma = 18$. Multiplying by 6 results in a practical train that fulfills the requirements: (90/18)(84/24) = 35/2.

Special Cases: There are three special cases for which the solutions can be simplified:

1. When N and D are both odd,

$$\left[\begin{array}{c} \frac{1/2 \left(N+D\right)}{1/2 \left(N+D\right)} \end{array}\right] \frac{N}{D} = \frac{N}{D}$$



is a solution for R = N/D and $\sigma = N + D$. 2. When N and D are of different parity,

$$\left(\frac{N+D}{N+D}\right)\left(\frac{2N}{2D}\right) = \frac{N}{D}$$

is a solution for R = N/D and $\sigma = 2(N + D)$. 3. When N and D are both integral squares

$$\left(\frac{\sqrt{N}}{\sqrt{D}}\right)\left(\frac{\sqrt{N}}{\sqrt{D}}\right) = \frac{N}{D}$$

is a solution for R = N/D and $\sigma = \sqrt{N} + \sqrt{D}$.

Pairs with Unequal Pitches

Solutions found through the Fundamental Theorem are for two meshes with identical pitch. To convert to an equivalent solution in which the two meshes are not of identical pitch, tooth numbers of the first mesh are multiplied by the diametral pitch of the first mesh; the same is done with the second mesh. Finally, dividing through by the greatest common divisor reduces the solution to primitive form.

Theorem III: If m, n, p, and q are a solution, from Theorem I, for identical-pitch gears, then, for gears with unlike pitch, $m' = mP_1/G$, $n' = nP_2/G$, $p' = pP_1/G$ and $q' = qP_2/G$. This is a solution for a reverted train when P_1 and P_2 are the diametral pitch of the first mesh, m/p, and second mesh, n/q, respectively. G is the greatest common divisor of the numerators.

EXAMPLE 3: Find a 2-mesh train for an instrument servo gear head, Fig. 2. Input/output = 0.35. Ratio of first mesh must be about 0.6, because of low-inertia requirements. Diametral pitch is 120 for both meshes; or, if possible, 120 for first mesh, 80 for second mesh. Inside diameter of gear case = 0.960 in.

Tooth sum σ is not specified, but inside diameter

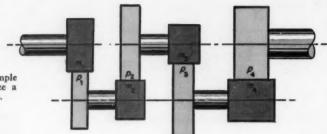


Fig. 3—Four-mesh reverted train. Example 4 shows the method used to synthesize a reverted train of more than two meshes.

of the case, 0.960 in., limits each of the sums (m+2p) and (q+2n) to less than 110 teeth. Equations to be solved, then, are (m/p)(n/q)=0.35=7/20=N/D, and $m+p=n+q=\sigma$; also, m+2p<110 and q+2n<110.

With t = 1, from Theorem I:

$$\left[\frac{a(b+d)}{c(b+d)}\right]\left[\frac{b(a+c)}{d(a+c)}\right] = \left(\frac{m}{p}\right)\left(\frac{n}{q}\right)$$

From this

$$\left[\begin{array}{c} \frac{1(27)}{1(27)} \end{array}\right] \left[\begin{array}{c} \frac{7(2)}{20(2)} \end{array}\right] = \left(\begin{array}{c} \frac{27}{27} \end{array}\right) \left(\begin{array}{c} \frac{14}{40} \end{array}\right) \; ; \; \sigma = 54$$

$$\left[\frac{1(8)}{20(8)}\right]\left[\frac{7(21)}{1(21)}\right] = \left(\frac{8}{160}\right)\left(\frac{147}{21}\right); \sigma = 168$$

$$\left[\begin{array}{c} \frac{1(17)}{2(17)} \end{array}\right] \left[\begin{array}{c} \frac{7(3)}{10(3)} \end{array}\right] = \left(\begin{array}{c} \frac{17}{34} \end{array}\right) \left(\begin{array}{c} 21\\ \hline 30 \end{array}\right) \; ; \; \sigma = 51$$

$$\left[\begin{array}{c} \frac{1(9)}{10(9)} \end{array}\right] \left[\begin{array}{c} \frac{7(11)}{2(11)} \end{array}\right] = \left(\begin{array}{c} \frac{9}{20} \end{array}\right) \left(\begin{array}{c} \frac{77}{22} \end{array}\right) \, ; \, \sigma = 99$$

$$\left[\frac{1(12)}{4(12)}\right]\left[\frac{7(5)}{5(5)}\right] = \left(\frac{12}{48}\right)\left(\frac{35}{25}\right); \sigma = 60$$

$$\left[\begin{array}{c} \frac{1(11)}{5(11)} \end{array}\right] \left[\begin{array}{c} \frac{7(6)}{4(6)} \end{array}\right] = \left(\begin{array}{c} \frac{11}{55} \end{array}\right) \left(\begin{array}{c} \frac{42}{24} \end{array}\right) \, ; \, \sigma = 66$$

The third of the preceding calculations satisfies tooth requirements; that is, 17 + 2(34) < 110 and 30 + 2(21) < 110. For most practical applications, these tooth numbers are usable without tooth modifications. First mesh = 17/34 = 0.5. This is not exactly 0.6, as desired for minimum inertia, but is satisfactory.

From Theorem III,

$$\left[\begin{array}{c} \frac{17(120)}{34(120)} \end{array}\right] \left[\begin{array}{c} \frac{21(80)}{30(80)} \end{array}\right] = \left(\begin{array}{c} \frac{17}{34} \end{array}\right) \left(\begin{array}{c} \frac{14}{20} \end{array}\right)$$

where the first mesh, 17/34, has diametral pitch = 120, and the second mesh, 14/20, has diametral pitch = 80. Center distance $H = \sigma/2P = 51/2(120) = 34/2(80) = 17/80 = 0.2125$ in.

Compounded Reverted Trains

By an extension of Theorem I it is possible to synthesize a reverted train with any number of meshes.

Theorem IV: Use the following procedure to find a biaxial train of k meshes, with ratio R, identical pitch, and arbitrary tooth sum σ , so that

$$\frac{m_1}{p_1} \quad \frac{m_2}{p_2} \quad \dots \quad \frac{m_k}{p_k} = R = \frac{N}{D}$$

and

$$m_1 + p_1 = m_2 + p_2 = \ldots = m_k + p_k$$

Find factors of tN and tD for t = 1, 2, 3, etc., such that $a_1a_2 \ldots a_k = tN$ and $c_1c_2 \ldots c_k = tD$. Then, the following constitute a solution:

$$m_1 = a_1(a_2 + c_2)(a_3 + c_3) \dots (a_k + c_k)/G$$

 $m_2 = a_2(a_1 + c_1)(a_3 + c_3) \dots (a_k + c_k)/G$

$$m_k = a_k(a_1 + c_1)(a_2 + c_2) \dots (a_{k-1} + c_{k-1})/G$$

and

$$p_1 = c_1(a_2 + c_2) (a_3 + c_3) \dots (a_k + c_k)/G$$

$$p_2 = c_2(a_1 + c_1) (a_3 + c_3) \dots (a_k + c_k)/G$$

$$p_k = c_k(a_1 + c_1)(a_2 + c_2) \dots (a_{k-1} + c_{k-1})/G$$

Example 4: Design an instrument train of 4 meshes located on two axes with ratio R=1/210, Fig. 3. Use identical-pitch gears. From Theorem IV, set t=1 and let $a_1=a_2=a_3=a_4=1$; and $c_1=2$, $c_2=3$, $c_3=5$, $c_4=7$; so that $a_1a_2a_3a_4/c_1c_2c_3c_4=N/D=1/(2)(3)(5)(7)=1/210$.

Upon substitution this yields

$$\left[\begin{array}{c} 1(1+3)(1+5)(1+7) \\ \hline 2(1+3)(1+5)(1+7) \end{array}\right]$$

$$\left[\begin{array}{c} 1(1+2)(1+5)(1+7) \\ \hline 3(1+2)(1+5)(1+7) \end{array}\right]$$

$$\left[\begin{array}{c} 1(1+2)(1+3)(1+7) \\ \hline 5(1+2)(1+3)(1+7) \end{array}\right]$$

$$\left[\begin{array}{c} 1(1+2)(1+3)(1+5) \\ \hline 7(1+2)(1+3)(1+5) \end{array}\right]$$

which, after each term is simplified and divided by the greatest common divisor, results in the primitive solution

$$\left(\begin{array}{c} 8 \\ \hline 16 \end{array}\right) \left(\begin{array}{c} 6 \\ \hline 18 \end{array}\right) \left(\begin{array}{c} 4 \\ \hline 20 \end{array}\right) \left(\begin{array}{c} 3 \\ \hline 21 \end{array}\right) = \frac{1}{210} \ ; \ \sigma = 24$$

Any number of practical gear trains may be derived from this primitive solution by multiplying each term by the same constant.

ACKNOWLEDGEMENT

Lead photo, courtesy U. S. Electrical Motors Inc.

Failure of shaft at press fit showing that plane of greatest weakness usually lies just inside the edge of the hub. Photo, courtesy Timken Roller Bearing Co.



A direct method for calculating stress-raising effects in

Press-Fitted Shafts

M. F. SPOTTS

Professor of Mechanical Engineering The Technological Institute Northwestern University Evanston, III.

POR rotating press-fitted shafts, a severe stress situation prevails just inside the hub. Fatigue failures frequently occur at this point. This article provides design rules for analysis of such conditions and shows how the desired value of the factor of safety can be obtained.

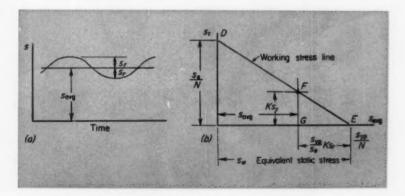
The state of stress at the shaft cross section just inside the hub is three-dimensional so that normal stresses s_x , s_y , and s_z may occur simultaneously with shear stresses s_{xy} , s_{yz} , and s_{zz} . The Mises-Hencky theory of failure shows that these stresses can all be

replaced by a single equivalent tension stress s given by

$$s^{2} = \frac{1}{2} \left[(s_{x} - s_{y})^{2} + (s_{y} - s_{x})^{2} + (s_{z} - s_{x})^{2} + (s_{z} - s_{x})^{2} + (s_{x} - s_{x})^{2} + ($$

Since some or all of these stresses vary in a rotating shaft, it is necessary to make suitable provision in shaft design for the harmful effects of such fluc-

Fig. 1—States of stress: a, Stress variation with time; b, working stress line and equivalent static stress.



tuation. Soderberg* has shown how a fluctuating stress can be replaced by an equivalent static stress s_{uv} . Fig. 1a indicates how a varying stress can be separated into average and range components s_{avg} and s_r .

In Fig. 1b, the average stress s_{avg} is plotted horizontally and the range stress s_r is plotted vertically. These stresses are first multiplied by the stress concentration factor K, if necessary. The working-stress line is taken as running from s_{yp}/N to s_e/N , where s_{yp} is the yield point stress for the shaft material, s_e is the endurance limit, and N is the factor of safety. A state of stress in which co-ordinates s_{avg} and Ks_r lie on the working-stress line is considered safe from fatigue failure. In fact, all points on the line are considered equally safe.

By similar triangles, it is easy to prove that length GE has the value Ks_rs_{yp}/s_e . Point F for the fluctuating stresses can then be replaced by point E which has a static stress s_{ye} , given by

$$s_w = s_{\text{avg}} + \frac{s_{yp}}{s_{\varepsilon}} K s_{\tau}$$
 (2)

The varying stresses of Equation 1 are separated into their average and range components as follows:

$$\begin{split} s_{\rm avg}^2 &= \frac{1}{2} \left[(s_{x\,\rm avg} - s_{y\,\rm avg})^2 + (s_{y\,\rm avg} - s_{z\,\rm avg})^2 + (s_{z\,\rm avg} - s_{z\,\rm avg})^2 + (s_{z\,\rm avg} - s_{z\,\rm avg})^2 + 6(s_{xy\,\rm avg}^2 + s_{yz\,\rm avg}^2 + s_{z\,\rm avg}^2) \right] \end{split} \tag{3}$$

$$s_r^2 &= \frac{1}{2} \left[(s_{xr} - s_{yr})^2 + (s_{yr} - s_{zr})^2 + (s_{zr} - s_{zr})^2 + ($$

$$(s_{zr} - s_{xr})^2 + 6(s_{xyr}^2 + s_{yzr}^2 + s_{zxr}^2)$$
 (4)

These values of s_{avg} and s_r are substituted into Equation 2. The factor of safety is then found by the traditional equation,

$$N = \frac{s_{yy}}{s_{vo}} \tag{5}$$

Fig. 2 shows a shaft with axes x, y, and z that is press-fitted into a hub. The press fit gives stresses s_y and s_z on element A, Fig. 2b. Bending moment

*C. R. Soderberg-"Factor of Safety and Working Stress," Trans., ASME, Vol. 52 (1), 1930, p. APM-13.

M(lb-in.) and torque T(lb-in.) give the normal and shear stresses s_x and s_{xy} of Fig. 2c.

Numerical Example: Let the stress from moment M in Fig. 2 be 3340 psi when calculated in the usual manner as a cantilever beam in bending. If the shaft is rotating so that the average stress is zero, the 3340 psi is all range stress. Let torque T be steady and give a shear stress of 4820 psi. Suppose a press fit gives compressive stresses of 9200 psi in the y and z directions.

Yield point value for the material is 54,000 psi and endurance limit is 45,000 psi. Let the stress concentration factor K at the edge of the hub be 1.65. Find the factor of safety for this shaft.

Solution: States of stress set up by the given data and press fit are: $s_{xavg} = 0$; $s_{yavg} = -9200$ psi; $s_{zavg} = -9200$ psi; $s_{zyavg} = 4820$ psi; $s_{zr} = 3340$ psi; $s_{yr} = 0$; $s_{zr} = 0$; $s_{xyr} = 0$; and $s_{yz} = s_{zz} = 0$. Also,

$$\frac{s_s}{s_{yp}}K = \frac{54}{45}$$
 (1.65) = 1.98

By Equation 3

$$s_{avg}{}^2 = \frac{1}{2} \ \Big[\ (0 + 9200)^2 + (-9200 + 9200)^2 + \\$$

$$(-9200 - 0)^2 + 6(4820^2 + 0 + 0)$$
 = 154,335,000

so that
$$s_{avg} = 12,420 \text{ psi}$$

$$s_r^2 = \frac{1}{2} \left[(3340 - 0)^2 + (0 - 0)^2 + (0 - 3340)^2 \right]$$

so that
$$s_r = 3340$$
 psi

By Equation 2, the equivalent static stress is

$$s_w = 12,420 + 1.98(3340) = 19,030 \text{ psi}$$

Hence, by Equation 5 the factor of safety is

$$N = \frac{54,000}{19,030} = 2.84$$

Effect of Compressive Stress: How much the compressive stresses from the press fit reduce the factor of safety is easily calculated. Should these stresses not be present, stress savg would have a value of 8350 psi. The range stress is unchanged at 3340 psi. Equation 2 gives an equivalent static working stress of 14,960 psi. The factor of safety then becomes 3.61.

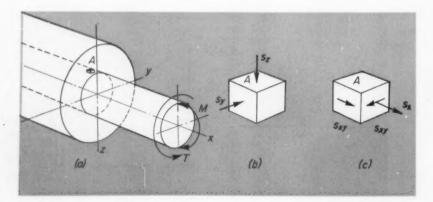


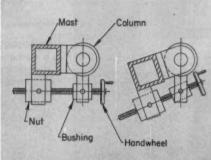
Fig. 2 — Stress components: a, Press-fit assembly; b, stress from press fit; c, stresses from moment and torque.

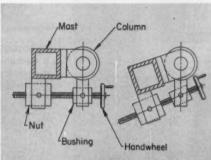
Motorized Tender Pushes Mobile Crane

Propulsion for a floor crane comes from a separately mounted motor and wheel. The prime mover, mounted at the back of the crane, is controlled by a power handle with a "dead man" control in its joint. The crane is used for positioning dies, fixtures, and similar heavy equipment where very fine control of location is required. Hydraulic metering valves which control motions are especially built for flows as low as 3 gpm.

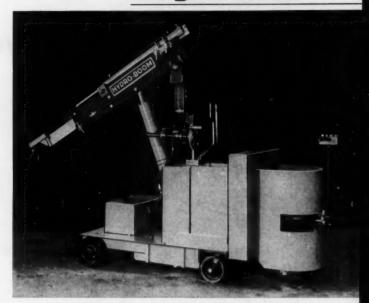
SINGLE-WHEEL tender moves up and down in a sleeve on its mounting bracket. Weight on the unit gives good wheel pressure for traction even when a heavy load shifts the crane cg far forward. Deadman switch stops the motor instantly if the handle is released and returns to an upright position.



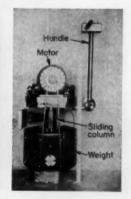


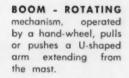


FINE METERING of fluid to the boom-extension cylinder can give nearly imperceptible motion to the load. To show the operator that the boom is moving, paddles were added to the shaft of the boom bearing.



COUNTERWEIGHTS keep the crane stable under heavy loads. The Hydro-Boom is produced by Vanguard Manufacturing Co., Cleveland, Ohio.



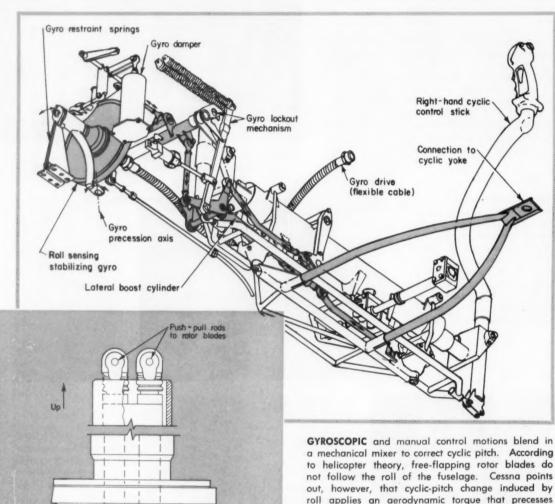




Gyro Stabilizer Cancels

ROLL STABILITY is improved in the Cessna Skyhook by a gyroscope mounted under the left front seat. This is one of the important stability mechanisms, growing out of Cessna's research on the YH-41, which permit the civilian Skyhook to

be flown hands-off. Other features are a supercharger pressure sensing device that corrects indirectly for changes in tail-rotor thrust, and longitudinal stabilizers that operate through the collective-pitch control at speeds above 30 knots.



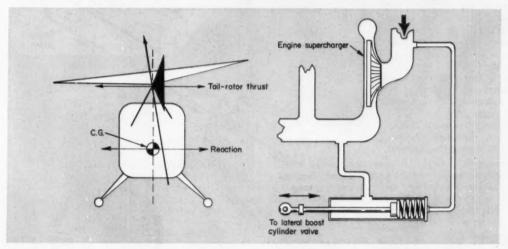
GYROSCOPIC and manual control motions blend in a mechanical mixer to correct cyclic pitch. According to helicopter theory, free-flapping rotor blades do not follow the roll of the fuselage. Cessna points roll applies an aerodynamic torque that precesses the rotor in the direction of the roll. Gyroscope, riding the fuselage, cancels this cyclic pitch change.

MECHANISMS for collective and cyclic pitch are in the base of the mast below the transmission. Two pushrods, one for each rotor blade, run through the hollow shaft to the mast top. Swash-plate action of the cyclic-pitch control is produced by a universaljoint cross with two additional couplings for the pushrods. Operation of controls pulls the bottom half of the universal joint out of alignment to produce a wobble in the cross. Collective pitch is controlled through a sleeve.

with pushrod couplings

Helicopter Roll

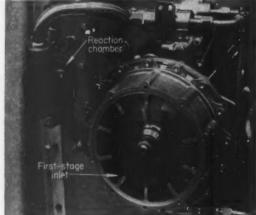




TAIL-ROTOR thrust contributes a rolling moment because its line of action is above the helicopter's center of gravity. Variation in main-rotor power calls for compensating adjustment in thrust of the tail rotor to keep the craft in trim. Corresponding rolling moment must be controlled by main-rotor cyclic pitch. Since the required correction is a function of power, pressure variation across the supercharger is used to operate a supplementary input to the cyclic-pitch control. Manifold pressure is not used because it will not distinguish between a dead engine and high power output.

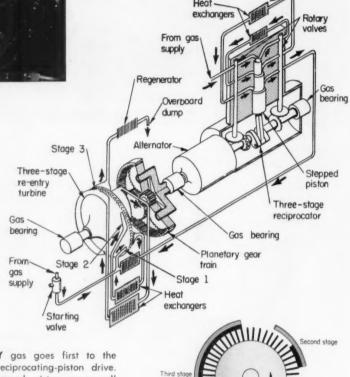
STABILIZERS control longitudinal stability in forward flight. They are free floating below 30 knots. Above 30 knots, where longitudinal stabilization is needed most, the stabilizers are operated by the collective-pitch control.





Back-to-Back Powerplants Hoard Satellite Fuel

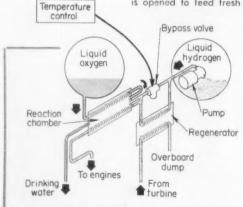
Power for satellite systems is supplied by back-to-back yoking of a turbine and a reciprocating engine supplied by a common propellant. Other novel features of the system include the absence of combustioneither internal or external. Energy is supplied to the propellant by heat exchangers that recapture waste heat from other satellite components and engine exhaust, and by chemical reaction of hydrogen and oxygen that would also supply drinking water in a manned satellite. The engine is a development of Sundstrand Aviation Division of Sundstrand Corp., Denver, Colorado.



HIGH-ENERGY gas goes first to the three-stage reciprocating-piston drive. A single stepped piston serves all stages. Heat exchangers collecting heat from other components in the satellite add energy to the gas after it passes through each stage.

Three-stage re-entry turbine uses exhaust from reciprocator as propellant. Gas leaving the last turbine stage has been expanded to 0.05 psia at 51 F. Additional heat is recovered even from this low-energy gas before it is dumped overboard. Starting valve is opened to feed fresh propellant directly to the turbine in the starting sequence.

Exhaust



LIQUID HYDROGEN serves as propellant for the engine. Modest energy demands of the high-efficiency system are provided by exothermic reaction of hydrogen and oxygen that produces water as a by-product. The engine operates an alternator with an output of 1 to 5 kilowatts. It can achieve a specific propellant consumption of 1 pound per horsepower hour.

Tape Loops Synthesize Standard Announcements

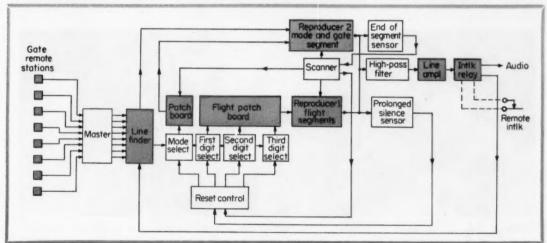
AIRPORT TERMINALS can use a new packaged announcement storage to call arrivals and departures. Separate tape loops store flight numbers, gates, and mode (arrival, first call, leaving). Synthesized messages are assembled from these fragments. Playback systems operate so quickly that there is no appreciable pause between message segments. The automatic announcing system was developed by Westrex Corp., Division of Litton Industries, Beverly Hills, Calif

SELECTOR panels, ordinarily focated at gates, have four rows of digits to select mode and a three-digit flight number. Gate location is recognized by a master-station scanner.





REPRODUCERS are made in two standard types: The smaller 15-segment unit has a playback head with each segment for virtually instantaneous playback. Larger 50-segment unit has a scanning playback head that takes a moment to locate the proper segment. Flight numbers can be stored on from one to three of the larger units. Follow-up information—leaving or arriving times and gate number—is stored on the quicker-acting 15-segment unit. Cartridges have no moving parts. Capstan and playback head are inserted by solenoid action through slots in the rear. A friction hold-down provides the necessary tape tension.



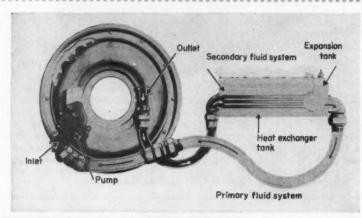
SELECTED segments are programmed on patch boards. A 45-cps signal is reproduced along with the message segment. It indicates that the message is still playing. When it cuts off, the end-of-segment sensor (relay held in by the signal) triggers the next step in

the announcement. Another signal at a different frequency returns the tape to starting position when the segment does not occupy the total tape length. High-pass filter keeps control signals from being broadcast.

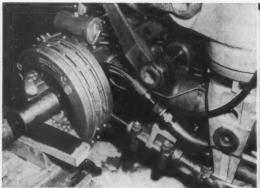


Liquid-Cooled Brakes Eliminate Aircraft "Hot Boxes"

Temperature building on braking surfaces of aircraft landing wheels is reduced as much as 1500 F by a new liquid cooling system. It uses two fluid stages and a heat exchanger to keep the brakes below 500 F. Manufacturer, B. F. Goodrich, Akron, Ohio, says weight of the new system is essentially the same as for conventional brakes.



LANDING WHEEL drives the pump that circulates primary fluid through the jacket. Primary fluid is a coolant such as glycolwater. Plain water is used in the secondary.



SPIN-UP mass is less than for regular brakes, which improves tire wear. The only regular attention the system needs is adding water to heat exchangers when needed. Source of water may be the same as for water-injection engines.



PROTOTYPE unit provides separate lines to inboard and outboard brakes on each landing-gear truck. Actuation system was also divided. If one braking, or cooling circuit fails in this setup, the remaining two brakes still have the total energy capacity of all four brakes, and safe stops could be made with only slightly longer landing distance.

A design guide:

Preventing Fatigue Failures

Prediction of fatigue strength or fatigue life is never a cut-and-dried process. All the pertinent factors can never be fully known. But reasonably accurate methods are available for calculating fatigue strength or life under various conditions.

Part 5 — Calculating Fatigue Strength

F. B. STULEN Assistant Chief Engineer

H. N. CUMMINGS Consulting Engineer

W. C. SCHULTE Chief Metallurgist

Propeller Div. Curtiss-Wright Corp. Caldwell, N. J. IN designing a machine component or structural part to resist oscillating loads, the design engineer or stress analyst should be familiar with the three important areas discussed in the preceding articles. These areas are: 1. Basic factors in fatigue strength. 2. Stresses in critical areas. 3. Service loads and environment.

Commonly used engineering formulas do not account for the stress concentrations caused by stress raisers. For this reason, in stress analysis the nominal alternating stress must always be multiplied by the appropriate stress-concentration factor. This factor may be considered equal to the theoretical, or geometric, stress concentration factor K_1 . However, fatigue tests usually show that the ratio of the long-life fatigue strengths of smooth and of notched specimens (K_I) is not as great as the geometric stress concentration seems to indicate.

As discussed in Part 2 of this series, the notchsensitivity factor, q, relates K_t and K_f . This factor is an attempt to rate various materials according to how well they maintain their fatigue strength if weakened by a stress-raiser.

The value of this parameter depends on the notch conditions: Type of material, size of the notch, level of alternating and steady stress, amount of residual stress at the root of the notch, strain-hardening index of the material, etc. For this reason, no precise rules have been formulated for computing this value. Peterson¹ has shown that the notch-sensitivity factor is largely a function of notch size. But unless the designer knows the notch-sensitivity factor for a given material and notch, a fairly high value, such as 0.7 or 0.8, should be used for high-quality engineering alloys.

The question of whether a stress-concentration factor should be applied to the steady, or static, stress component has for many years been widely argued in engineering circles. Smith has found, on the basis of many tests on small laboratory specimens, that no stress-concentration factor need be applied to the steady stress component; that is, only the nominal stress need be used.2 Apparently, in small notches a residual compressive stress is developed during the fatigue process and this residual stress counteracts the applied tensile steady stress. However, there is no logical reason to omit the stress concentration on steady stresses when the notch or hole is relatively large. If no specific information is available concerning the effect of stress concentrations on the steady component of stress, it is certainly conservative to multiply the steady stress by the geometric stress-concentration factor.

Before a designer can judge whether a part will have sufficient fatigue strength, he should know how the fatigue strength of the selected material will be affected by the expected service environment. In addition, a designer should recognize that nearly all published fatigue data on materials are obtained in controlled laboratory tests on small polished specimens; these values are seldom obtained in full-scale parts made under normal production conditions.

Many practical factors reduce fatigue strength below laboratory values (Part 3 and 4 of this series). Because of this, the fatigue strength of a part, based on the actual alternating stress, seldom exceeds 70 per cent of the handbook value. It is often much less, even when care is used during manufacturing.

Fatigue Strength and Fatigue Life

1References are tabulated at end of article.

Even if all the pertinent factors are known, a very small variation in fatigue strength or applied stress will cause a disproportionately large change in fatigue life. For example, in one case it was found that a stress increase of only 30 per cent reduced fatigue life from 1,000,000 to 75,000 cycles, a 13.3:1 reduction.

It is very dangerous to design a part for a specified life for the following reasons:

1. Service loads are seldom known to the neces-

sary degree of precision. Extreme stresses caused by infrequent overloads or malfunction are rarely known, but they can have a serious effect on the fatigue life of the part.

2. Stress distribution is known precisely only in very simple structures. In most cases the stress at critical locations can only be approximated by engineering formulas.

3. Metallurgical deficiencies and poor surface conditions may be introduced during manufacture. In addition, residual stresses may arise in assembly. These are often hard to determine with any degree of accuracy.

4. When test specimens that represent the actual structure are tested in fatigue, they do not always give true fatigue strengths. They may not be representative of mass-production manufacturing conditions. Also, the accelerated laboratory tests are not usually representative of time-dependent effects, such as corrosion. Finally, test-loading conditions are only simplified approximations of expected service loads.

5. The unknown scatter in fatigue introduced by inconsistencies in the material, variations in heat-treatment, variations in manufacturing of the component, etc., cause an unknown degree of scatter in the finished piece.

6. "Life to failure" is a vague term. It may mean life to complete fracture. However, in most cases a part is considered to have failed when a very small crack has developed.

Shanley³ says: "In evaluating methods of analysis, it is most important to decide whether the immediate objective is to prevent fatigue failures or to predict fatigue life. Methods that are entirely satisfactory in the first case are likely to be quite inadequate in the second case. Much of the pessimism that one encounters in discussion of fatigue analysis is the result of looking at the picture from the wrong direction.

"For example, nearly all the tests made to evaluate the cumulative-damage theory have been reported in terms of life only. Comparing predicted

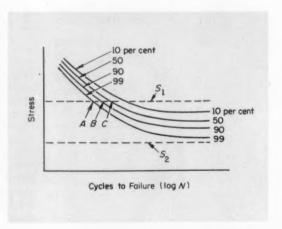


Fig. 20—Typical P.S-N curves. These curves predict the number of specimens or parts that will fail at a given stress or number of cycles. Such curves are not generally available in the literature.

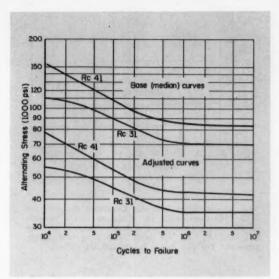


Fig. 21—Adjusted S-N diagram, showing base (median) and adjusted S-N curves for SAE 4340 steel at Rc 31 and 41, after stress relieving. Ultimate tensile strength of the Rc 41 steel is 192,000 psi, that of the Rc 31 steel, 143,000 psi. Base curves are used in drawing approximate P-S-N curves.

life with test life often gives discouraging results. But if the same results are compared on the basis of effective stress, the picture is much more encouraging."

A method has been proposed for designing for high reliability by deducting from the average strength a specific number of "standard deviations of strength" for each uncertain factor—for example, service conditions, skill of subcontractors and vendors, test methods, etc. Unfortunately, very few data are at present available on standard deviations.

Standard deviation = $[\Sigma (\bar{x} - x_i)^2/n - 1]^{\frac{1}{2}}$, where x is the average of n measurements and x_i is one of the measurements, with $i = 1, 2, 3, \ldots n$. Term $\Sigma (\bar{x} - x_i)^2$ is, then, the sum of the squares of the amounts by which the individual measurements deviate from the average of the measurements and is therefore a measure of the scatter in the measurements.

P-S-N Curves

It must be recognized that there is considerable scatter in the fatigue life or fatigue strength of any material. Most published S-N curves are single curves representing average or median fatigue life to fracture. Since such curves are based on tests using relatively few specimens, no measure of the scatter in fatigue life can be obtained.

In order to compute reliability with respect to fatigue, it is necessary to have S-N curves of constant probability of survival (or failure). These are sometimes called P-S-N curves. A typical curve is shown in Fig. 20. This curve indicates that many specimens of a material were tested at a vibratory stress represented by horizontal line S₁. It is then

apparent from the graph that 99 per cent of the specimens are expected to survive the number of cycles associated with point A; that is one per cent will have failed before reaching the point. Point B corresponds to 90 per cent survival and 10 per cent failures, etc.

Obviously, service stress S_2 must be below the fatigue limit of the 99 per cent curve in order to assure that less than one per cent of the parts in service will eventually fail.

P-S-N curves are shown in some sources, 4.5 but in general such curves are not available in the literature. However, in the examples that follow a method is given for constructing an approximate P-S-N diagram, Fig. 21, provided a median S-N curve is available.

Design Data

To ascertain whether a critical area is properly designed, the following should be considered whenever data are available:

- The S-N curve for the material, with corresponding probability values.
- Any manufacturing, service, or maintenance conditions that might affect fatigue strength; also, the degree of this effect.
- The "modified Goodman diagram" for the material, if steady stresses exist in addition to the vibratory stresses (Fig. 22).
- 4. The law of cumulative fatigue damage.
- Anisotropy factors; that is, the ratios of fatigue strength in the two transverse directions to the fatigue strength in the longitudinal direction.

A number of different stress situations may arise. Four such cases are discussed here. These cases are among those most likely to occur.

Case I. Constant-Amplitude Service Stresses: As mentioned previously, little information is available on scatter of fatigue life or fatigue strength. A measure of such scatter is the "standard deviation." Values of the standard deviation of the long-life fatigue strengths of some typical hot-worked modern alloys that have been heat-treated and tested in the smooth condition are shown in Table 1. These values are of course only approximations.

The data in this table show that the standard deviations of the long-life fatigue strengths of high-quality forged alloys are between 5 and 8 per cent of the long-life fatigue strengths. Al-Ni-bronze has a higher value, but this metal is not commonly used as a structural alloy. If no values are available for a specific alloy, 8 per cent of the long-life strength may be assumed as a standard deviation, provided the material is of good quality.

Fatigue tests on a various alloys have shown that for a fixed number of cycles, fatigue-strength values have a reasonably "normal" distribution. For this reason, a rough indication of the fatigue limits associated with fixed percentages of survivals or failures can be made by subtracting a certain number of standard deviations from the mean fatigue strength.

This number is obtained by multiplying the mean standard deviation by the following factors:

Survival Rate (per cent)	Deviation Multiplication Factor
90	1.3
95	1.6
99	2.3
99.9	3.1
99.99	3.7

The law of distribution of fatigue strength has never been accurately determined for any material, particularly in the region where the percentage of survival is very high. For this reason, the foregoing estimate of fatigue strength for a given survival rate can only be considered as a guide.

Not only must the fatigue strength of a selected alloy be corrected for scatter, but it must also be corrected for all surface conditions introduced in manufacturing and in service. These correction factors were discussed in Part 3 and 4 of this series.

When the corrected fatigue limit (corrected for scatter, surface conditions, etc.) has been calculated, it can then be compared to the alternating stress expected in service. The ratio of the corrected fatigue limit to the service stress may be loosely thought of as the safety factor in fatigue. It should be sufficiently high to allow for errors in estimating the service stress. This safety factor is not a precise concept, since it loses its significance when the variation inherent in the fatigue strength is further complicated by a variation in the applied stress.

Example: A certain part is to be designed for long-life fatigue loading of ±150 lb. The sign indicates that the load alternates between tension and compression. A tentative design is made, and fatigue stress at the critical area, based on stress concentrations (Part 1 and 2), and on the absence of any fretting or corrosion, is computed as ±37,000 psi. If there is any danger that fretting or corrosion may occur, design stress should not be over 33 per cent of this value. For extreme cases it should be even less.

Table 1—Standard Deviations of Fatigue Strength

Material*	Ultimate Tensile Strength (1000 psi)	Long-Life Fatigue Strength (1000 psi)	Amount of Standard Deviation (1000 psi)	Standard Deviation (per cent of fa- tigue strength)
4340 Steel	140	71	3.5	4.9
Cr-Ni-Mo	190	85	6.7	7.8
	230	90	5.3	5.9
	260	97	6.3	6.5
4350 Steel Cr-Ni-Mo	300	100	4.4	4.4
Titanium Alloy 6Al-4V	145	84	5.4	6.4
Aluminum Alloy 7076-T61	76	27	1.6	6.0
Al-Ni-Bronze 5Ni-10Al	117	48	4.5	9.4
Beryllium Copper 2 Be	175	36	2.7	7.5

^{*}Alloys are heat-treated, hot-worked; specimens smooth, subjected to long-life, rotating-beam tests.

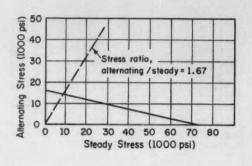


Fig. 22—Modified long-life Goodman diagram for SAE 4340 steel at Rc 41. Ultimate tensile strength of the steel is 192,000 psi, endurance limit is $\pm 43,000$ psi, and $K_1=2.6$ for both alternating and steady stresses. For this curve, N=10,000,000 cycles.

Stresses are longitudinal; that is, in the direction of forging of the part. SAE 4340 steel is to be used, and is not to be heat treated to a hardness greater than Rc 45. Base or median S-N curves for this steel for hardnesses 31 and 41 are shown in Fig. 21.

Fig. 21 shows that the long-life base fatigue strength of Rc 31 steel is about 70,000 psi, and that of the Rc 41 steel is about 85,000 psi. However, these are 50 per cent probability values. Therefore, these values must be scaled down to the required survival rate.

Assume that no more than one part per thousand must fail-that is, there must be a 99.9 per cent probability of survival. Then the values in Fig. 21 will be reduced by about three standard deviations. To allow for various uncertainties in requirements, service load, environmental conditions, and manufacturing deficiencies, these scaled-down values should be further reduced by a "factor of ignorance" of, say, 1.5. Assuming that no information is available on the long-life standard deviation of the steels, 8 per cent of the base long-life fatigue strength may be used, as suggested earlier. Then the adjusted value of the long-life fatigue strength of the Rc 31 steel = $\pm [70,000-3(0.08)70,000]/1.5 =$ $0.51 \ (\pm 70,000) = \pm 36,000 \ \text{psi}; \ \text{and for Re 4l}$ steel = $\pm [85,000 - 3(0.08) 85,000]/1.5 = 0.51$ $(\pm 85,000) = \pm 43,000$ psi.

The adjusted S-N curves in Fig. 21 were constructed on the assumption that the reduction factor, 0.51, is valid throughout the range of fatigue strengths covered by the base S-N curves. This assumption is conservative. It has been shown⁶ that there is a decrease in the standard deviation. This means that the percentage of variation for high stress levels would, if anything, decrease, since it would be the ratio of a smaller standard deviation to higher strength level.

In view of the accumulated assumptions necessary to get even an approximate solution, it seems advisable not to take a chance on the Rc 31 steel, but to specify the Rc 41 steel. In addition, the

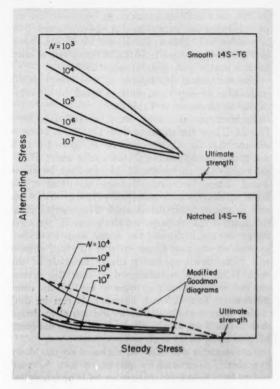


Fig. 23—Effect of steady stress on reversed stress for a smooth and a notched aluminum alloy.

completed part should be stress-relieved.

There are at least two bases available in establishing a safety factor for the specified steel—the mean fatigue strength and the scaled-down fatigue strength at 99.9 per cent probability. In the first case, 85/37 = 2.4 and in the second case, 43/37 = 1.2. In either case the computed factor is meaningless unless the way in which it was derived is stated.

Case II. Steady Stress Superimposed on Constant Amplitude Stress: There is ample evidence in fatigue literature that a steady load superimposed on a fully reversed load reduces the effective fatigue strength of the material. The reduction is usually assumed to be linear unless known to be otherwise. For steels, this has been shown to be a reasonable assumption. However, for certain aluminum alloys this reduction has been shown to vary with conditions.

The modified Goodman diagram, Fig. 22 and 237, is a convenient device for the solution of fatigue-reduction problems. The Goodman line joins the endurance limit to the ultimate tensile strength. Even in the case of the notched alloy, the line in Fig. 23 is drawn to the ultimate tensile strength of the alloy. However, as stated in Part 2 of this series, it would be conservative, particularly in the case of large notches, to divide the ultimate tensile strength and the endurance limit by the K_t of the notch before constructing the diagram, as shown in Fig. 22.

Example: A certain part is being designed for long life with an alternating load of 150 lb and a superimposed steady tension of 90 lb. The ratio of alternating to steady stress will be 150/90 = 1.67. A tentative design has been made, with a large notch at the critical area, with an estimated K_t of 2.6. What are the allowable nominal vibratory and the allowable nominal steady stresses if the part is to be made of SAE 4340 steel heat-treated to Rc 41? There is no fretting or corrosion. Nominal stresses are computed as if there were no notch.

The modified Goodman diagram in Fig. 22 is conservatively based on the adjusted S-N curve for alternating stresses, Fig. 21, and on maximum allowable stresses computed by dividing both the alternating and the ultimate tensile strength by the K_t value. A straight line was drawn from the maximum allowable alternating stress, $\pm 43,000/2.6 = 16,500$ psi to the maximum allowable steady stress, 192,000/2.6 = 74,000 psi. The dashed line in Fig. 22 was drawn at a slope A = 1.67, the ratio of alternating to steady stress. Its intersection with the (solid) Goodman line gives, in round numbers, an allowable nominal alternating stress of $\pm 14,500$ psi and an allowable nominal steady stress of 8,500 psi, giving a maximum stress of 23,000 psi with A = 1.67.

Case III. Alternating Stresses of Varying Amplitudes: A histogram of a possible loading situation

Table 2-Data for Case III

Stress Level (1000 psi)	Service Cycles, n (1000 cycles)	Adjusted Life, N (1000 cycles)	Cumulative Damage n/N
	(a) Fin	st Tentative Design	
_	_	Re 31 Re 41	Re 41
57	20	10 65	$2/6.5 \pm 0.31$
54	40	15 100	4/10=0.40
51	50	35 140	5/14=0.36
48	50	200	5/20 = 0.25
45	80	350	8/35 = 0.23
42	100	>10,000	Total=1.55
39	160	720,000	
36	200		
33	200		
30 (or less)	9,100		
	(b) Seco	nd Tentative Design	
	_	Re 31 Re 41	Re 31
38	20	350 >10,000	2/35=0.00
36	40	600	4/60=0.07
34	50	>10,000	Total=0.13
32	50		
30	80		
28	100		
26	160		
24	200		
	200		
22			
20 (or less)	9,100		
Stress	Service	Adjusted	Cumulative
Level	Cycles, n	Life, N	Damage
(1000 psi)	(1000 cycles)	(1000 cycles)	n/N
	(c) S	afety Factor=1.3	
	00	50	2/5=0.40
49.5	20		
49.5 47	40	75	
	40 50	120	5/12=0.41
47	40		5/12=0.41 5/19=0.26
47 44	40 50	120	5/12=0.41 5/19=0.26 8/30=0.27
47 44 41.5 39	40 50 50	120 190	5/12=0.41 5/19=0.26 8/30=0.27
47 44 41.5	40 50 50 80	120 190 300	4/7.5=0.60 5/12=0.41 5/19=0.26 8/30=0.27 10/45=0.22 Total=2.16
47 44 41.5 39 36.5	40 50 50 80 100 160	120 190 300 450	5/12=0.41 5/19=0.26 8/30=0.27 10/45=0.22
47 44 41.5 39 36.5	40 50 50 80 100 160	120 190 300 450 >10,000	5/12=0.41 5/19=0.26 8/30=0.27 10/45=0.22
47 44 41.5 39 36.5 34	40 50 50 80 100 160	120 190 300 450 >10,000 afety Factor=1.2	5/12=0.41 5/19=0.26 8/30=0.27 10/45=0.22 Total=2.16 2/9.5=0.21 4/15=0.27
47 44 41.5 39 36.5 34 45.5	40 50 50 80 100 160 (d) 8	120 190 300 450 >10,000 afety Factor=1.2	5/12=0.41 5/19=0.26 8/30=0.27 10/45=0.22 Total=2.16 2/9.5=0.21 4/15=0.27
47 44 41.5 39 36.5 34 45.5 43.4	40 50 50 80 100 160 (d) 8	120 190 300 450 >10,000 afety Factor=1.2	5/12=0.41 5/19=0.26 8/30=0.27 10/45=0.22 Total=2.16 2/9.5=0.21 4/15=0.27 5/21=0.24
47 44 41.5 39 36.5 34 45.5 43 41 38.5	40 50 50 80 100 160 (d) 8	120 190 300 450 >10,000 afety Factor=1.2 95 150 210 280	5/12=0.41 5/19=0.26 8/30=0.27 10/45=0.22 Total=2.16 2/9.5=0.21 4/15=0.27 5/21=0.24 5/28=0.18
47 44 41.5 39 36.5 34 45.5 43.4	40 50 50 80 100 160 (d) 8	120 190 300 450 >10,000 afety Factor=1.2	5/12=0.41 5/19=0.26 8/30=0.27 10/45=0.22 Total=2.16

expected on a structural component was shown in Fig. 3, Part 1 of this series. The histogram in Fig. 24 shows a distribution of the stresses that would be expected in a tentative design. The most difficult problem in evaluating this histogram is to determine the damaging effect of the small number of high stresses, say 33,000 to 57,000 psi, on the service life of the part.

In cases of this kind, the cumulative-damage law may be applied. Many studies of cumulative damage have been made and reported in the literature.²³ Grover²⁴ reviewed the literature on the subject and concluded that attempts to improve the Palmgren-Langer-Miner linear-cumulative-damage law^{8,0,10} have resulted in increasingly complicated theories. Although in each of the proposed theories test results showed definite improvement over the Miner hypothesis—at least for the material used for the tests—none has become universally acceptable. Because the linear cumulative hypothesis is simple and easily used, it has been chosen, with one modification, for the following example.

The linear cumulative damage law states that if the median fatigue life of a given material at a given stress is N cycles, and n cycles of stress (n < N) have been applied to the material, the resulting damage has used up n/N of the fatigue life of the material. Obviously, if this is true the material should fail when the sum of these fractions becomes unity. Tests reported in the literature have shown the actual sum of such damage fractions to vary from 0.2 to 7.0 or more. Actually, there is about a 7 to 1 uncertainty in results obtained by using this linear-cumulative-damage law without any modification. For this reason, a conservative approach is to base its use on an adjusted curve, such as those in Fig. 21.

EXAMPLE: A structural component is to be subjected to the varying loads whose magnitude and frequency are shown in Fig. 3 (Part 1). Plans call for SAE 4340 steel, heat-treated to no more than Rc 40. A tentative design has been made and the critical stresses, based on stress concentrations and

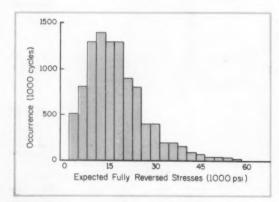


Fig. 24—Histogram of expected fatigue stresses in the tentative design of Case III. This is for a life of 10,000,000 cycles for the component whose service loads are shown in Fig. 3, Part 1.

on the absence of any fretting or corrosion, are expected to be as shown in Fig. 24. Adjusted S-N curves for SAE 4340 at Rc 31 and Rc 41 are shown in Fig. 21. Determine if SAE 4340 steel can be used for this design and, if so, at what hardness.

For the stated conditions, a tabulation of the cumulative damage computations based on the critical stresses is shown in Table 2a.

To construct this table, first list the data from Fig. 24. Then, list the data from Fig. 21. It becomes evident that Rc 31 steel cannot be used, for it is not strong enough to last 20,000 cycles under 57,000 psi stress. The listing for Rc 31 can then be abandoned. Since cumulative-damage computation for Rc 41 steel gives more than unity, it is probably not safe to specify even Rc 41 steel. The conclusion at this point is that the expected stresses in the tentative design are too high, and the design must be revised by making the part larger so that the unit stresses will come down to the available strength of the steel. If the part is redesigned so that the stresses are two thirds as high as those in Fig. 24, the compilation in Table 2b can be made. It can be concluded from a study of the second tentative design that it would be worthwhile to investigate the feasibility of using Rc 31 steel.

To determine the safety factor based on the Miner hypothesis, a cut-and-try procedure may be used to find by what factor the stresses must be multiplied to bring the summation of n/N to unity.

Table 2c lists values obtained with trial factor 1.3. Evidently the factor 1.3 is too large. Table 2d lists values for 1.2. It appears, then, that using the Rc 31 steel for the second tentative design would give a cumulative-damage safety factor of about 1.2, based on the adjusted S-N curve.

The adjusted curve itself gives strength values based on three standard deviations—to allow for scatter in the material—and a factor-of-ignorance of 1.5. This gives adjusted values of 51 per cent of the mean (base) strengths, or an adjusted factor of 1/0.51 = 1.96. Combining the damage factor and the adjusted factor gives an overall safety factor of 2.3. This takes into consideration possible discrepancies due to variation in material, cumulative-damage, and other factors.

Case IV. Steady Stresses Superimposed on Alternating Stresses of Varying Amplitudes: Steady stresses superimposed on alternating stresses lower the resistance of a part under a given number of cycles

Table 3-Data for Case IV

Stress Level (1000 psi)	Service Cycles, n (1000 cycles)	Adjusted Life, N (1000 cycles)	Cumulative Damage n/N
+38 +35	10	35	1/3.5=0.29
±38 +30 +36 +30	10	60	1/6=0.17
+36 + 30	40	90	4/9-0.44
$\pm 34 + 30$	30	150	3/15=0.20
$\pm 34 + 25$	20	190	2/19=0.11
$\pm 32 + 20$	50	480	5/48=0.10
$\pm 30 + 10$	80	>10,000	Total=1.31
$\pm 28 + 10$	100		
+26 + 5	160		
+28 +10 +26 +5 +24 +5	200		
+22 +5 +20 (or less)	200		
+5 (or le	gs) 9,100		

of alternating stress. The solid curves in Fig. 23 show the results of tests on an aluminum alloy.

The Rc 41 and Rc 31 steels being used as examples in this article are known to have curves resembling those in the upper part of Fig. 23. Thus, for these steels the conventional straight lines of modified Goodman diagrams-such as those in Fig. 22are conservative. Straight lines drawn from fatigue strength for zero steady stress, down to ultimate tensile strength for zero alternating stress, lie under the actual test lines. Of course, in cases where the nature of steady stress effect on fatigue strength is not known, it is risky to assume that straight lines may be used.

The following example shows the need for carefully assessing the effect of steady stresses in lowering the fatigue strength of a structural material.

EXAMPLE: What is the effect of superimposing steady stresses, as shown in Table 3, on the second tentative design of the example in Case III?

The effect of the steady stresses is to lower the fatigue strength for any given cycle life. This of course results in a shortening of the fatigue life of the material for any given stress level. In other words, it reduces the value of N, in the formula used to compute cumulative damage. To find the reduced values of N, a family of Goodman lines based on the adjusted curve in Fig. 21 for the Rc 31 steel can be prepared, as shown in Fig. 25. Just as was shown in Fig. 23, different lines must be drawn for different values of cycle life. For example, the uppermost line in Fig. 25 was drawn from a stress value scaled from the adjusted curve of Fig. 21 for 10,000 cycles.

Combined alternating and steady stresses are shown in the first column of Table 3. Each line lists two quantities. The first is the alternating stress, the second is the steady tensile stress. The total

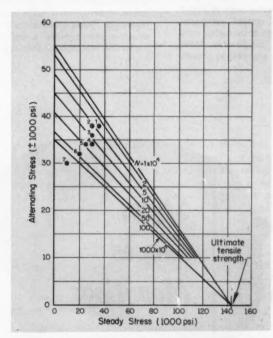


Fig. 25-A family of modified Goodman diagrams for Rc 31 steel, based on the adjusted curve of Fig. 21.

number of service cycles at each alternating stress level is the same as in Case III.

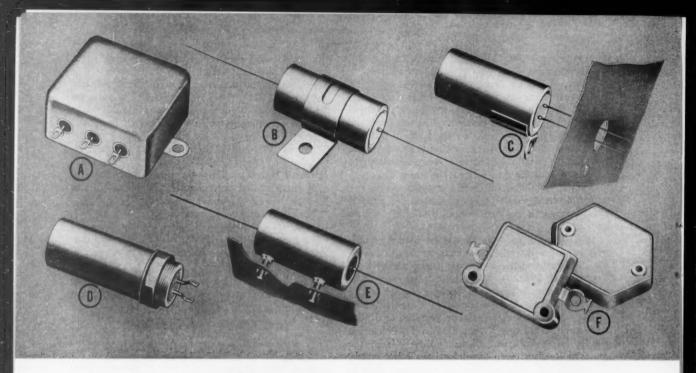
Values of adjusted life are determined as follows: For the first item, $(\pm 38 + 35)$, locate the point on Fig. 25 representing alternating stress 38 and steady stress 35. This point (point 1 in Fig. 25), lies about halfway between the 2 \times 10⁴ and the 5 \times 10⁴ Goodman lines and is therefore entered in the adjusted-life column (Table 3) as 3.5 × 104. The other values of N are similarly determined and values of n/N are computed as in Case III. These can then be listed in the cumulative-damage column.

The high value of the summation of n/N = 1.31, against 0.13 for Case III, shows such damaging effect that a redesign is required. The methods outlined here and in Case III should be repeated.

Part 6 of this series will discuss biaxial fatigue stresses.

REFERENCES

- R. E. Peterson—Stress Concentration Design Factors, John Wiley and Sons, New York, N. Y., 1963.
 J. O. Smith—"The Effect of Range of Stress on the Fatigue Strength of Metals," Univ. of III. Engineering Experiment Station Bulletin, Vol. XXXIX, No. 26, February 17, 1942.
 F. R. Shanley—"Discussion of Methods of Fatigue Analysis," Wright Air Development Division Technical Report 59-507, August, 1959, p. 182.
 H. N. Cummings E. R. Styley, and W. C. Schulte, "Tougsting."
- H. N. Cummings, F. B. Stulen, and W. C. Schulte—"Investiga-tion of Materials Fatigue Problems Applicable to Propeller Design," Wright Air Development Division Technical Report 54-531, May, 1955.
- H. N. Cummings, P. B. Stulen, and W. C. Schulte—"Investiga-tion of Materials Fatigue Problems," Wright Air Development Division Technical Report 56-611, March, 1957.
- F. B. Stulen, H. N. Cummings, and W. C. Schulte—"Relation of Inclusions to the Fatigue Properties of High-Strength Steels," Proceedings International Conference on Fatigue of Metals, London, 1956, p. 439.
- B. J. Lazan and A. A. Blatherwick—"Fatigue Properties of Aluminum Alloys at Various Direct Stress Ratios. Part I— Rolled Alloys," Wright Air Development Division Technical Report 52-307, Part 1, December, 1952.
- 8. A. Palmgren—"Die Lebensdauer von Kugellagern," ZVDI, Vol. 68, 1924, pp. 339-341.
- B. F. Langer-"Fatigue Failure from Stress Cycles of Varying Amplitude," Transactions ASME, Vol. 59, 1937.
- M. A. Miner-"Cumulative Damage in Fatigue," Transactions ASME, Vol. 67, 1945.
- J. A. Bennett—"A Study of the Damaging Effect of Fatigue Stressing on X4130 Steel," Proceedings ASTM, Vol. 46, 1946.
 F. E. Richart Jr. and N. M. Newmark—"An Hypothesis for the Determination of Cumulative Damage in Fatigue," Proceedings ASTM, Vol. 48, 1948, pp. 787-800.
- J. Marin—"Evaluation of Fatigue Life for Members Subjected to Varying Stress Amplitudes," Unpublished Paper.
- W. R. Shaffer—"Cumulative Damage of Metals by Fatigue," M. S. Thesis, Pennsylvania State University, University Park, Pa., 1951.
- Pa., 1951.
 J. M. Sinclair and T. J. Dolan—"Use of a Recrystallization Method to Study the Nature of Damage in Fatigue of Metals," Proceedings of the First U. S. National Congress of Applied Mechanics, June, 1951, pp. 647-651.
 H. F. Hardrath and E. C. Utley Jr.—"An Experimental Investigation of the Echavior of 248-T4 Aluminum Alloy Subjected to Repeated Stresses of Constant and Varying Amplitudes," NACA TN 2798, October, 1952.
- W. C. Brueggeman, M. Mayer Jr., and W. H. Smith—"Axial Fatigue Tests at Two Stress Amplitudes of 0.032-Inch 248-T Sheet Specimens with Circular Hole," NACA TN No. 983, July,
- W. Serensen—"On the Endurance of Cast Iron and Steel Under Repeated Loading of Varying Amplitudes," Proceedings International Conference on Fatigue of Metals, London, 1956.
- I. Smith, D. M. Howard, and F. C. Smith—"Cumulative Fritigue Damage of Azially Loaded Alclad 758-T6 and Alclad 248-T3 Aluminum Alloy Sheet," NACA TN No. 3293, September, 1955.
- A. K. Head and F. H. Hooke—"Random Noise Fatigue Testing," Proceedings International Conference on Fatigue of Metals, London, 1956, p. 301.
- J. Schijve and F. A. Jacobs-"Research on Cumulative Damage in Fatigue of Riveted Aluminum Alloy Joints," Report M. 1999, National Luchtvaartlaboratorium, January, 1956.
- H. T. Corten and T. J. Dolan—"Cumulative Fatigue Damage Proceedings International Conference on Fatigue of Metal London, 1956, p. 235.
- A. M. Freudenthal—"Cumulative Damage Under Random Loadings," Proceedings International Conference on Fatigue of Metals, London, 1956, p. 257.
- Horace J. Grover—"Cumulative Damage Theories," Development Division Technical Report 59-507, p. 207.



Integral Mountings

A Bathtub capacitor with ear tabs for horizontal mounting (parallel to chassis surface). Lead connections can be located on side or on top. Side connections permit stacked mounting.

B Tubular capacitor with C-clamp welded to metal case for horizontal mounting. Capacitor shown is moisture proof. Capacitors are also available with both leads located at same end. Attached clamp saves assembly time.

Tubular capacitor with angle bracket welded to metal case for vertical mounting (perpendicular to chassis surface). Bracket may be attached at any location along the length of the case to permit throughchassis mounting. This feature permits minimum lead lengths to be used for special circuits but requires two holes in the chassis.

Tubular capacitor with threaded housing for vertical mounting.

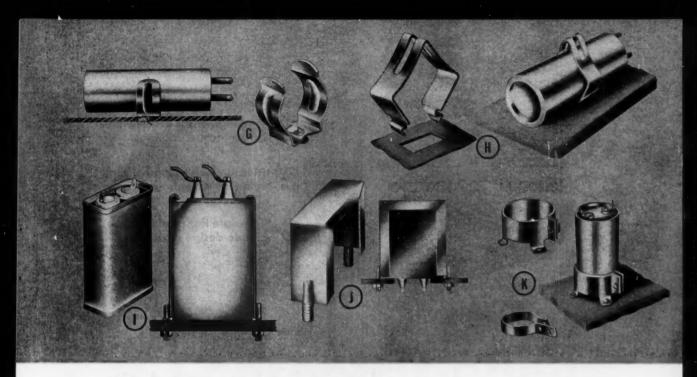
This capacitor type is available with solder terminals or flexible leads and requires only one hole in chassis.

E Tubular capacitor with two radially positioned threaded studs for horizontal mounting. This type of mounting is suitable for high vibration conditions and in cramped locations where side mountings cannot be used.

Specially shaped capacitors with molded plastic or ceramic cases. Capacitors can be fitted with flanges, tapped inserts, or through-holes for mounting. Case material and construction can provide a salt-water immersion seal against humidity.

Fixed Capacitors

Styles
Shapes
Mountings



Separate Mountings

Quickly installed spring-steel clip for horizontal capacitor mounting. Capacitor can be mounted in various axial positions. The open cradle permits easy mounting and removal of capacitor. No bolts are required since the clip is rigidly held in rectangular hole in the chassis.

Snap-over clip for horizontal mounting. No bolts are required. The clip fits into a rectangular hole in the chassis and provides a springloaded grip.

Hook strap for vertical mounting of rectangular capacitor. A recess in the top of the capacitor is necessary to provide effective gripping. Capacitors with terminals at the bottom require appropriate cutouts in the chassis.

Inverted U-strap for vertical mounting of rectangular capacitor. The strap has threaded studs attached. Holes are required in chassis for capacitor terminals and strap studs.

Strap and ring for mounting tubular capacitors. Straps are used for horizontal mounting. For vertical mounting, ring permits capacitor positioning through hole in chassis.

FRANK WILLIAM WOOD JR. Advanced Designs Inc. Vienna, Va.

APACITORS are available in many styles and shapes. Electrical capacity and voltage rating are usually specific values determined by circuit requirements. Capacitor style and the location and method of mounting, however, present a variety of choices. Selecting the most suitable possibility is simplified by using the answers to the following questions as a guide.

- 1. Must special environmental conditions be met? Some equipment specifications require certain types of dielectric materials, case materials, etc.
- 2. How much space is available? In most cases capacitor costs increase as size decreases.
- Are lead lengths critical? A 1/16-in. difference in lead length can cause unbalance in some circuits, while variations of a foot or more make no difference in other circuits.

- 4. Do maintenance problems exist? Depending on end use, some equipments warrant plug-in capacitors that are easy to replace; others can have the capacitor soldered into the circuit in relatively inaccessible locations.
- 5. Is the capacitor to be located near high-heat emitting components? High ambient temperatures may require compensation for changes in electrical capacity.
- 6. Must both sides of the capacitor be "floating," or can one side be grounded to the case? Two grounded types are available. One type has two leads, one of which is connected to the metal case. The other type has only one lead with the metal case providing the ground connection.

To satisfy various conditions, capacitors are available with either integral or separate mounting provisions. Principal features and arrangements for both types are pictured.

Here's a reliable, direct procedure

Find high-stress areas with brittle lacquer coatings.

Measure actual load-strain relations with strain gages.

Translate test results into simple design equations.

for predicting load-stress relations in

ETHODS of analyzing the behavior of conventional structural shapes under load are well documented in the literature. As long as a structural element can be treated as an isolated load-carrying member, a "handbook" procedure usually can be found to guide design calculations.

The same does not hold true for built-up structures of the type shown in Fig. 1. Little information has been published on techniques for accurately determining maximum stress levels in such structures, which are common in a wide range of applications from rocket and turbojet engines to industrial fans and compressors.

Some theoretical investigations of strut-connected concentric shells have been conducted, but these efforts have been directed mostly at finding bending moment and load distributions or deflections at various points in the structure. Energy methods are generally used for these calculations.

This approach, unfortunately, does not give an accurate picture of the true stress distribution. Also, any calculated deflection holds only for the point under consideration. For other points, the calculations must be repeated. This duplication of effort can be tedious and time consuming.

Moreover, the results obtained with this approach can be assumed to be approximate only since the rigidity of the connections is open to speculation. Further approximation must be expected because of discontinuities, such as holes and peculiar boundary or edge conditions, which hamper accurate analysis.

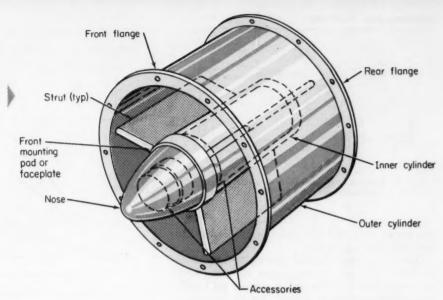
The method presented here was developed to eliminate these shortcomings. Based on experimental stress-analysis techniques, it provides a simplified, direct procedure for predicting the behavior of strutconnected, concentric-shell structures.

Typical Structure: Consider the typical concentricshell structure shown in Fig. 1. It represents the inlet housing to a gas-turbine engine. The outer shell, flanged for attachment to the main equipment, is connected to the inner cylinder by means of three aerodynamically shaped struts spaced at equal intervals. Airborne struts are commonly of bent sheetmetal construction to diminish weight. The inner shell supports a faceplate to which is attached accessory equipment.

These accessories are generally protected by a suitable aerodynamic nosecone. Additional equipment may be attached to the rear of the faceplate within the geometric boundaries of the inner shell.

Normally, accessory units consist of motors, small pumps, starters, generators, alternators, gear boxes, and fuel supplies. Weight of this equipment may

Fig. 1—Concentricshell structure to house and support engine accessories.



Concentric-Shell Structures

ARTHUR F. MENTON, Servo Corp. of America, Hicksville, N. Y.

impose severe loads on the housing. In addition, if the main structure is airborne or mobile, forces developed by acceleration and deceleration of the accessories will be transmitted to the housing.

Test Procedure: A normal assembly is mounted to a vertical plate in its horizontal position. The vertical plate simulates the fixity offered by the compressor housing, which is directly aft the inlet housing when the engine is assembled. The nosecone is removed and a special loading fixture is attached to the faceplate of the inner shell, Fig. 2. The loading fixture is simply a rod through which bending and torsional loads can be applied.

Vertical loads are applied hydraulically at two locations on the rod to produce different combinations of binding moment and shear at the faceplate. For torque loads, a lever arm is attached to the rod

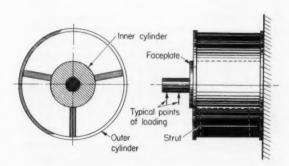


Fig. 2—Location of loading rod and mounting plate during tests.

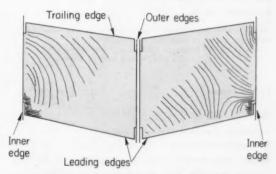


Fig. 3—Typical stress cracks in brittle-lacquer coating on most severely loaded strut.

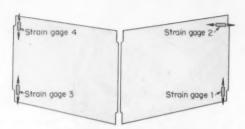


Fig. 4—Location and orientation of strain gages for strain measurements on strut in Fig. 3.

and torque is applied by a dead-weight load at the desired position on the arm.

Initially, a brittle-lacquer coating is applied to the entire structure. A continuously increasing load, randomly located on the rod, is applied until sufficient stress patterns are noticed, Fig. 3. Resistancewire strain gages are next mounted at the highly stressed locations indicated by the brittle-lacquer test, Fig. 4.

Vertical loads are then applied at two stations along the rod, Fig. 2. Each of these loads is applied in increments until strain-gage readings give evidence of permanent set due to yielding, Fig. 5 and 6. After the two bending tests are completed, torsional loads are applied in increments, again until yielding is noted in the structure, Fig. 7. At the same time, the angular deflection of the inner cylinder and faceplate is measured with respect to the outer flange, Fig. 8.

Although these test data are not extensive, they simulate effectively an actual loading on the structure. From these data, equations for predicting the stresses and deflections within the structure under service conditions can be readily developed.

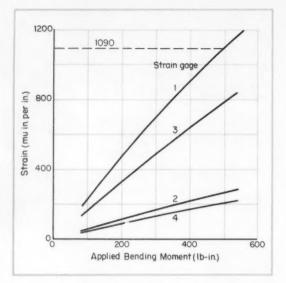


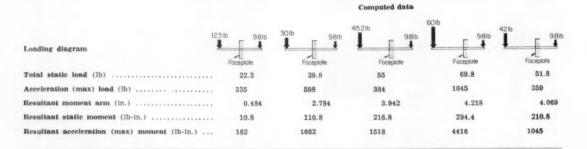
Fig. 5—Strain versus moment for load applied 2.78 in. forward of faceplate in structure of Fig. 2.

In some instances, the structure may include a loading bracket to support accessories attached to the outer shell. Then, another similar series of tests would be required to evaluate the effects of this additional loading.

Analytical Correlation: Final step in this method of analysis is to transform the test data into equations that can be used in design calculations. To illustrate this procedure, a typical design example will be used, Fig. 1.

Suppose that there are five different accessories which may be separately mounted on the front of the faceplate. Each accessory is to be used for a

Tabl	e 1—Acces	sory Mountin	g Data		
AND REAL PROPERTY OF THE PARTY	Case A	Case B	Case C	Case D	Case E
Accessory	Starter	Gearbox	Given data Alternator	Starter-Generator	Generator
Weight (lb)	12.5	30	45.2	60	42
Moment arm to faceplate (in.)	4	5	5.6	5.56	5.95
Continuous torque at faceplate (lb-in.)	250	250	250	160	320
Acceleration load (g)	15	15	7	15	5



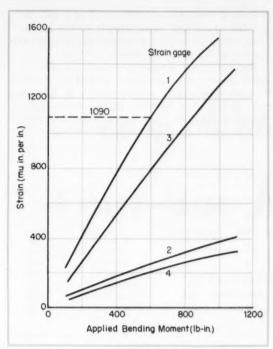


Fig. 6—Strain versus moment for load applied 3.95 in. forward of faceplate in structure of Fig. 2.

different application of the engine. With each of these choices, the inner cylinder must also house a small generator weighing 9.8 lb, with its center of gravity 4 in. behind the faceplate. Basic data for the five possibilities are given in Table 1.

The two positions for test loading correspond to the resultant moment arms for Cases B and C, Table I. (Theoretically, any other combination of two moment arms also could be used). That is, the first test load (Fig. 5) is applied 2.78 in. from the face-plate while the second test load (Fig. 6) has a 3.95-in. moment arm. Strain gages, previously located from the brittle-lacquer test (Fig. 3), are used to determine when yielding of the material begins.

In this particular arrangement, initial yielding occurs at a strain of 1090 mu in. per in. at strain gage 1, Fig. 4. This strain corresponds to a yield strength of 31,610 psi which agrees with that of the material used. The high strain at this gage is mainly from stress concentration due to the cutouts in the strut at the joint with the inner shell.

Since the test is conducted for two loading conditions, two equations can be set up relating shear and moment to stress at strain gage 1. These equations can be solved for shear and moment coefficients, which show just how much effect each load component has on the resultant stress. These coefficients, C_1 and C_2 , along with the known yield strength of the material can then be used to predict the reading of strain gage 1 under any combination of loads in shear and bending.

Data for calculation of coefficients, C1, C2, are

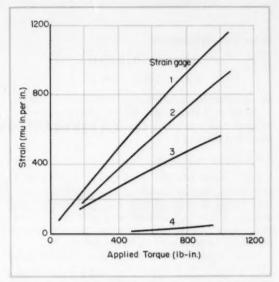


Fig. 7—Strain produced at strut by applied torque at faceplate of structure in Fig. 2.

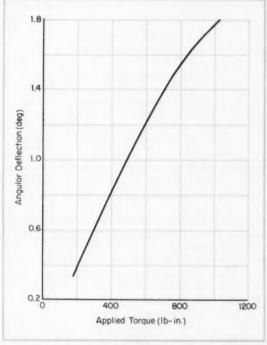


Fig. 8—Angular deflection of inner cylinder faceplate with respect to outer flange as measured during torque test (Fig. 7).

given in Table 2. Resultant stress S at gage location l is

$$S = C_1 V + C_2 M \tag{1}$$

where V is the shear load, lb, and M, is the bending moment, lb-in.

Substitution of data from Table 2 into Equation 1

yields two relationships:

$$31,610 = 180 C_1 + 500 C_2$$

 $31,610 = 152 C_1 + 600 C_2$

By simultaneous solution, $C_1=99.05$ in. ⁻² and $C_2=27.59$ in. ⁻³ Hence, the general expression for resultant stress S at strain gage 1 as a consequence of shear and bending is

$$S = 99.05 V + 27.59 M \tag{2}$$

Fig. 7 shows that the conditions for strain gage 1 are critical. Similar studies of the other gage positions might be made but are not significant in this analysis. However, when test data from two or more strain gages are nearly equivalent, parallel studies of each of the positions would be in order.

From Equation 2, assuming shear loading only (M=0), V=31,610/99.05=319.13 lb or, approximately, 320 lb. This result means that about 320 lb can be applied at the faceplate without yielding.

Torsion loads introduce another shear stress that must be added to the previously calculated resultant stress. Operating torques of the accessories are listed

Table 2—Strain Gage 1 Data					
Vertical Shear (lb)	Moment (lb-in.)	Strain (in. per in.)	Stress (psi)		
180	500	1090×10-6	31,610		
	Vertical Shear (lb)	Vertical Moment Shear (lb) (lb-in.)	Vertical Shear (lb) Moment (lb-in.) Strain (in. per in.) 180 500 1090×10-4		

in Table 1. These torques were determined separately and are transformed into equivalent strains, Table 3, with the torque plot for strain gage 1, Fig. 7. The corresponding calculated shear stresses τ are given in Table 3. These stresses have fixed values for each accessory, and can be added to Equation 2 to give the total stress, S_T . Thus,

$$S_T = 99.05 V + 27.59 M + \tau \tag{3}$$

Equation 3 can now be used to find the total stresses for all five cases:

Case A,
$$S_T = 99.05 (335) + 27.59 (162) + 8850 = 46,500 \text{ psi}$$

Case B,

$$S_T = 99.05 (598) + 27.59 (1662) + 8850 = 114,800 \text{ psi}$$

Case C,

$$S_T = 99.05 (384) + 27.59 (1518) + 8850 = 88,800 \text{ psi}$$

$$S_T = 99.05 (1045) + 27.59 (4416) + 5400 = 231,400 \text{ psi}$$

Each of these total stresses exceeds by a wide margin the 31,610 psi yield strength of the material. Hence, none of the five accessories can be used with the present inlet-housing design.

Redesign of the housing is necessary to meet load requirements. Possible design alterations include:

1. Use heavier gage strut material. 2. Eliminate strut cutouts that aggravate stress concentration. 3. Modify acceleration requirements. 4. Modify support dimensions to reduce overhang.

Table 3—Constant Stresses from Torque

Case	Continuous Torque (lb-in.)	Strain (in. per in.)	Stress (psi)
A	250	305×10-4	8850
\boldsymbol{B}	250	305×10-6	8850
C	250	305×10-	8850
D	160	200×10-6	5400
E	320	385×10-4	11,150

In this instance, the strut was modified by eliminating all cutouts to reduce stress concentration to a minimum. The redesigned version proved satisfactory on all counts when the previous analysis was repeated.

The power of the method is evident from the example. Without destructive testing or lengthy theoretical calculations, the adequacy of a structure is reviewed. Furthermore, for any other loading situation, stresses can now be immediately determined.

They Say . . .

"The unavailability of engineering data to a user, such as the designer, limits his ability to make the best judgments. The problems associated with storage and retrieval of engineering data are somewhat different than those for literature, wherein extensive abstraction is necessary. The latter, being principally in narrative form, must be read for assimilation, word for word, as it deals basically with concepts and abstract relationships. It should be simpler to code, index, and store engineering data as it deals mainly with specific values and designs, either in alphanumeric form, or symbolized pictorially on engineering drawings. Hence, the systemization of engineering data awaits only management's full recognition of the extent of the needs. System design and development for machine storage to facilitate rapid retrieval and selection is entirely feasible today with known techniques and adaption of currently available hardware. The matter is one for executive decision, since firm requirements have been proven to exist."—WILLIAM S. HUTCHINSON, Assistant Chief, Mech. & Eng. Programs Branch, Standardization Div., Armed Forces Supply Support Center.

Selecting the dimensions of

Four-Bar Mechanisms

for best force conditions via the optimum transmission angle

PREBEN W. JENSEN

Remington Rand Univac Div. of Sperry Rand Corp. South Norwalk, Conn.

BEST force-transmission conditions exist in a four-bar linkage when the force along the coupler drives the output rocker at 90 deg, Fig. 1. The angle between the coupler and the rocker is called the transmission angle. Transmission angle is the complement of pressure angle.

Fig. 2 shows the mechanism of Fig. 1 in the two

Transmission angle μ = 90 deg

Coupler
Unit force

Rocker

Fig. 1—Ordinary four-bar mechanism in a configuration at which the transmission angle is 90 deg and at which a unit force along the coupler produces greatest torque in the rocker.

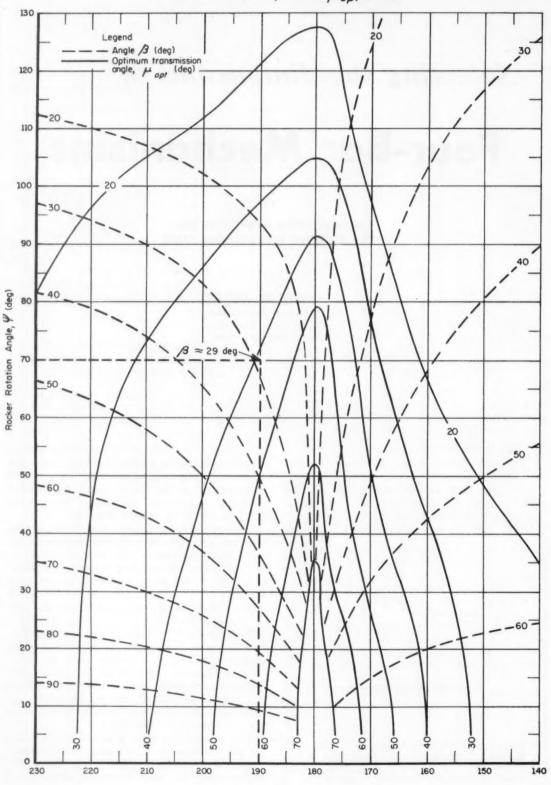
configurations at which the transmission angles are greatest and least in a cycle of motion. Maximum transmission angle μ_{max} occurs when crankpin P is at position P_1 on the line of centers AB extended. Minimum transmission angle μ_{min} occurs when crankpin P is at P_2 between A and B.

Obviously the transmission angle is 90 deg at only one position in the angular movement of the rocker from one extreme position to the other. At other positions between these extremes, the deviations from 90 deg are a measure of the reduction in effectiveness of force transmission. Thus, an objective in linkage design is to proportion the links so that these deviations are as small as possible.

Among a family of possible four-bar mechanisms, there is one mechanism that has a minimum transmission angle which is greater than the minimum transmission angles of all the others. The minimum transmission angle of this one mechanism is called the "optimum" transmission angle, µopt. This particular linkage has the best dimensions for most effective force transmission.

The accompanying Chart is an easy way to single out the optimum transmission angle from a family. Angle β is also taken directly from the Chart. This angle enables the linear dimensions of the corresponding four-bar linkage to be found by construc-

Chart of Angles $oldsymbol{eta}$ and $\mu_{\it opt}$ (deg)



tion and measurement, or by calculations if desired.

Given Data: Center distance AB, output angular stroke ψ of the rocker, and input angular displacement α of the crank are the known data at the start. These dimensions are frequently the defining dimensions of a desired linkage, Fig. 3. When they are not the defining dimensions, or if these dimensions are not immediately available from the initial specification of the desired linkage, they can be found by simple layout of the mechanism according to whatever defining data are given.

For one problem, a fast working stroke and a slow return may be desired. For another, the opposite in requirements may be wanted. Fig. 3 illustrates an input angle α greater than 180 deg. This choice is merely convenient. An input angle less than 180 deg (counterclockwise rotation) is just

P. Alling P. In the second of the second of

Fig. 2—Configurations of four-bar mechanism at which transmission angles are maximum μ max and minimum μ min.

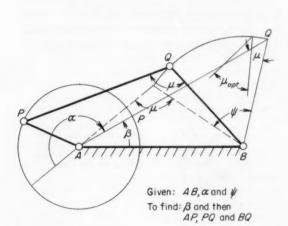


Fig. 3—Four-bar mechanism at three configurations in a cycle of motion, including the extreme or dead-point positions where the transmission angles μ are unequal.

as likely and can be chosen as needed to meet conditions of a given problem. The Chart applies to either case.

To Use the Chart: Enter crank angle α as abscissa and rocker angle ψ as ordinate to locate a point on the Chart.

Read angles β and μ_{opt} , interpolating to the nearest degree if the point lies between the curves.

To illustrate, let $\alpha = 190$ and $\psi = 70$ deg. Dashed co-ordinate lines on the Chart locate the point having angles $\mu_{opt} \approx 41$ and $\beta \approx 29$ deg.

Linkage Construction to Get Dimensions: An example is helpful in explaining the steps of construction to get specific linkage dimensions. Suppose a four-bar linkage is defined by the foregoing values of angles α , β , ψ , and AB = 4 in., Fig. 4.

- 1. Construction angles $\alpha/2=95$ deg and $\psi/2=35$ deg at fixed centers A and B, respectively, to locate point R.
- 2. Draw M'M, the perpendicular bisector of AR.
- 3. Draw a line perpendicular to BR from A and extending beyond K.
- Construct circular arc AKR about M' as center and arc LE about M as center.
- 5. Construct angle $\beta = 29$ deg to locate points P and Q.
- 6. Measure AP=1.48 in., the crank dimension; PQ=3.84 in., coupler length; and BQ=2.68 in, rocker length.

Family of Mechanisms: Arc LE is the locus of all possible Q points and arc KA is the locus of all P points of a family of four-bar mechanisms. Each

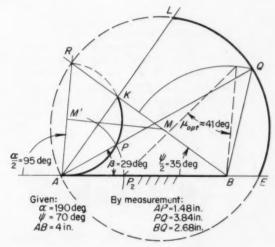


Fig. 4—Construction to find dimensions of links AP, PQ, and BQ at optimum transmission angle and a center distance of 4 in.

mechanism of the family fulfills given conditions $\alpha = 190 \deg$ and $\psi = 70 \deg$.

To get the dimensions of another member of the family, any line AP'Q' is drawn at a second angle β' , Fig. 5. Again, measurement of distances AP', P'Q', and BQ' gives the dimensions sought.

The mechanism with proportions AP'Q'B, however, has a minimum transmission angle that is smaller than the optimum transmission angle of the mechanisms with proportions APOB. In other words, the former deviates from 90 deg by a greater angle than the latter. Fig. 5 illustrates this difference quantitatively. The μ_{opt} obtained from the Chart for angle β is 41 deg. This magnitude from the Chart is verified by construction and measure-

By measurement: AP'=1.92 in P'Q'= 3.18 in. BQ'= 3.33in 36 deg

Fig. 5-Comparison of two four-bar mechanisms from same family, one of which has the optimum transmission angle and the other, a minimum transmission angle that is smaller than optimum.

ment. The value of the minimum transmission angle μ_{min} for angle β' by measurement is 36 deg.

An optimum transmission angle of 40 deg is a good practical limit. For $\mu = 40$ deg, maximum $\psi = 91 \text{ deg when } \alpha = 180 \text{ deg. Thus, } 173 \text{ deg} \leq \alpha \leq$ 195 deg. is indicative of a practical range for angle a.

Obviously from Fig. 2, maximum and minimum transmission angles depend greatly upon rocker angle \(\psi \). Curves on the Chart also indicate when rocker angle \(\psi \) is too great to accommodate arbitrarily prescribed values of minimum transmission angles.

Optimum transmission angle as the criterion of best proportions for a four-bar linkage was introduced by Alt1 in Germany. It has been used little in this country. Credit for the Chart also goes to Alt.2

Occasionally an author3 in this country mentions transmission angles and recommends limits for design. Some debate has also appeared in the literature4 over whether transmission angle is the best criterion for mechanism design, particularly when dynamic forces are involved. The transmission-angle concept is discussed in all of the references.

Equivalent Mechanisms: Cam design is based frequently on maximum pressure angle. The same end is reached if cam design is based on optimum transmission angle. The Chart applies directly to eccentric-type cam mechanisms with oscillating followers.

Likewise, the Chart is applicable to other mechanisms that are basically four-bar in construction, such as the intermittent mechanism shown in Fig. 6.

REFERENCES

- H. Alt—"Der Ubertragungswinkel und seine Bedeutung für das Konstruieren periodischer Getriebe," Werkstattstechnik 26 (1932), H. 4, S. 61.
- H. Alt—"Das Konstruleren von Gelenkvierecken unter Benutzung einer Kurventafel," VDI-Z 85 (1941) Nr. 3, S. 69.
- 3. R. Aronson—"Large-Oscillation Mechanisms," Machine Design, Vol. 32, No. 23, November 10, 1960, p. 190.

 4. K. Hain—"Drag-Link Mechanisms," Machine Design, Vol. 30, No. 13, June 26, 1958, p. 104. K. Hain—"Angewandte Getriebelehre," Herman Schroedel Verlag, Hannover, 1952.
- R. Kraus—Getriebelehre, Vol. 1, Second Edition, Verlag Technik, Berlin, 1954.

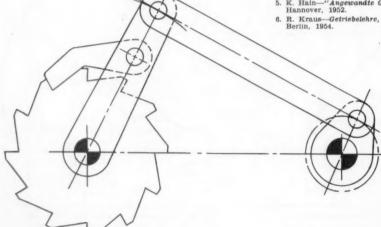


Fig. 6-Typical intermittent-motion mechanism of basic four-bar type that is well suited for proportioning by the Chart.



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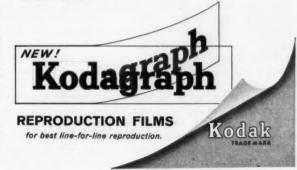
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A close look at design and application factors for

Filament-Wound Pressure Vessels

RICHARD GORCEY

Group Leader
Solid Propulsion Components
Rocketdyne
Div. of North American Aviation Inc.
Canoga Park, Calif.

A T FIRST glance, filament winding is a deceptively simple process consisting merely of winding a reinforcing material and a resinous binder around a mandrel to form a part. Despite simplicity, real or apparent, end products can exhibit properties as different as night and day. Results are influenced by: 1. Basic material properties of the components (reinforcement, resin, and hardener). 2. The way the components are combined and handled. 3. The winding equipment used. 4. The type of mandrel employed. 5. Shape of the part.

It is perhaps in the field of pressure-vessel fabrication that filament winding shows greatest potential.

Technical Advantages: Features of filament-wound technique include:

WEIGHT SAVING: It is primarily due to the extremely high stress levels and low density that can be obtained with filament-wound structures, and the resultant weight saving, that this method of fabrication competes with homogeneous metals in many applications. Table 1 compares significant properties.

CORROSION RESISTANCE: Reinforced-plastic materials suitable for

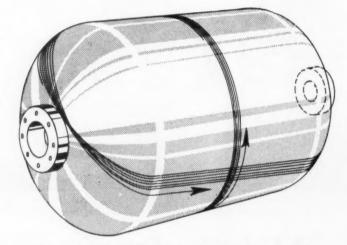


Fig. 1-Two types of filament windings on a pressure vessel.

filament-wound structures are extremely corrosion resistant. Resins used in these materials are quite frequently applied to metallic structures to improve corrosion resistance.

THERMAL CONDUCTIVITY: As with other reinforced-plastic materials, the thermal conductivity is extremely low in comparison with homogeneous metallic structures. This is a factor in hot-fluid tanks and certain pipe applications.

NOTCH SENSITIVITY: All high strength-to-density metallic structures suffer from notch sensitivity which results in premature failure of the parts. Owing to the nature of a filament-wound structure, this problem does not exist.

SIZE LIMITATION: Basic principles are such that large-size parts can be fabricated as simply as small-size

parts. Size limitations are imposed only by fabricating machines. At the present, machines can fabricate parts up to 15 ft diam and 65 ft length.

POTENTIAL FOR FUTURE IMPROVE-MENT: Potential lies mainly in the area of high strength-to-density ratios, higher modulus, and improved temperature resistance. It is anticipated that possibly within the next five years, a composite stress level of 300,000 psi can be realized. In addition, high-strength filament materials will be available with melting temperatures as high as 2500 F.

Eventually, work on whiskers should advance to the point where they can be used in filament winding. The greatest potential would be for the carbon whisker which might result in structures with stress levels of 850,000 psi with a modulus





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Table 1—Properties of Pressure-Vessel Materials

Property	——Filament Type E Glass	Winding— High Modulus Glass	Titanium	Steel
Density (lb/cu in.)	0.075	0.081	0.163	0.285
Tensile Yield Strength (psi)	130,000	115,000	150,000	220,000
Tensile Yield Strength/Density(in.)	174×104	142×10^{4}	92×104	78×104
Modulus of Elasticity (psi)	5×10 ⁶	9.0×10^{6}	16.5×10^{6}	30×10^{6}
Elongation (per cent)	2.36	1.28	0.91	0.78

of elasticity of 85×10^6 psi and a density of 0.061 lb per cu in. This would mean a strength-to-density ratio of 1400×10^4 .

IMPACT AND SHATTER RESISTANCE: As with all reinforced-plastic materials, the impact resistance of filament-wound structures is quite good. Whereas a metallic structure might dent from a blow, a filament-wound structure would spring back and retain its shape. A filament-wound vessel is shatter proof.

REPRODUCIBILITY AND RELIABILITY: Since filament-wound parts are made on mandrels, excellent dimensional reproducibility can be assured since the ID of the part will be in all cases determined by the OD of the mandrel. Parts made from the same mandrel will always be identical.

Techniques of Winding: Filament winding has three basic patterns: Circumferential, helical, and sequen-

Circumferential winding is the simplest of the three. The filaments are placed on the part at approximately 90 deg to the axis of the part, Fig. 1. The part to be wound is rotated between centers while the filaments being wound on the rotating mandrel are advanced through a delivery eye. Since a part that is wound only with filaments lying in the circumferential direction cannot withstand any longitudinal loads, additional longitudinal material must be added.

Helical winding eliminates the problem of laying in longitudinal material. In this method, filaments are laid down upon the mandrel at some angle to the axis, depending upon design considerations. It is necessary that the filaments be laid down with the utmost accuracy. It is also necessary to provide some means of turnaround at the end of

the stroke. As filament is laid on the surface of a mandrel, it traces a helical path. As the filament goes around the tank for the second time, it is spaced a certain distance away from the preceding strand. This spacing is dependent upon the winding angle and the size of the part.

Sequential winding is similar to helical winding except that each time a pass around the vessel is made, the filament is laid down next to the previous one.

Quite frequently, a combination of circumferential and helical winding or circumferential and sequential winding is utilized. In this case, the circumferential winding primarily resists the hoop loads and the helical or sequential winding primarily takes up the longitudinal loads.

Filament-winding equipment can be found in many forms. Since this is a relatively new field, no equipment standards have been developed, nor is there any standard equipment on the market. Most equipment in use has been individually tailored to suit the fabricator. Rocketdyne has developed numerically-controlled winding machines in which the winding pattern is programmed by a digital tape.

Other points of variance are the methods and equipment for impregnating, tensioning, and handling the reinforcing material. Impregnation has been accomplished by three methods. The first technique—winding with a dry material and impregnating it on the mandrel—has been discarded by most fabricators, especially when the reinforcing material is glass.

The second, and widest used, method of impregnation is known as wet winding. Reinforcing material is drawn through a resin bath prior to being wound on the mandrel.

The third method of impregnation involves a preimpregnating process. Here, the reinforcing material is impregnated with a resin prior to being used in the winding operation. An important consideration in the use of preimpregnated material is that it lends itself to quality-control techniques before actual application to a part. In addition, the resin content of a filament-wound part will be the same as the resin content of the impregnated strand.

In wet winding, the control of resin content is accomplished through the control of resin viscosity and winding tension. In general, the lower the resin viscosity and the higher the winding tension, the lower the final resin content. Another factor to be considered in the determination of resin content is the diameter of the part being wound. If the viscosity and the winding tension are constant, a small-diameter part will have a higher resin content than a larger diameter part.

Still another problem is the control of resin content when wet winding occurs in helical winding. Owing to the nature of the winding in which there is a crossing over of fibers, pockets occur in varying degrees. These pockets become resin traps.

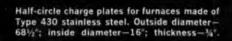
All of the problems just discussed can be avoided with preimpregnated roving. Since the resin content is predetermined before winding, it can be maintained easily during the winding operation. Increased diameters can have no effect and increased tension will only serve to produce a better wound structure.

Materials for Filament Winding: Materials used in filament winding fall into two categories: The reinforcing material and the resin system. For pressure vessels, where one of the main considerations is high strength, only two classes of reinforcing materials can presently be considered — high-strength steel wires or glass filaments—and only one class of resin system—an epoxy.

The choice of the steel wire is determined by its tensile strength. The higher the tensile strength, the better the strength-to-density ratio in a wound structure.

Four factors usually govern the choice of glass reinforcements: Tensile strength, modulus of elasticity,







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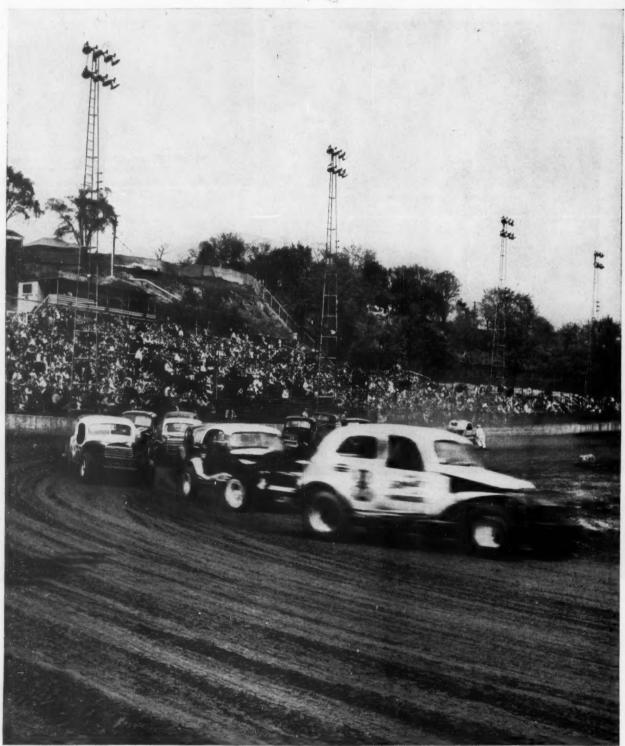


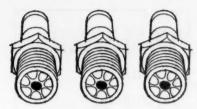
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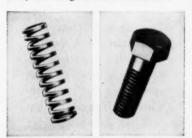


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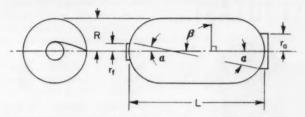


Fig. 2-Geometry of filament-wound cylindrical vessel.

wet-strength retention, and fatigue properties. To protect the glass fibers, and also to provide a better bond to the resin, a chemical composition known as a size is applied to the fibers. Although different sizes do not affect the basic strength of the fiber, they do result in different tensile strengths in the final part. In addition, the size directly influences the wet-strength retention of the material. Unfortunately, the size that results in the best tensile strength under ambient conditions does not result in the best wetstrength retention and fatigue properties.

Modulus of elasticity is a rather straightforward parameter and is strictly a function of the basic formulation. Currently, standard glass has a modulus of 10×10^6 psi and high-modulus glass is about 15 to 19×10^6 psi. Tensile strength of high-modulus glass is slightly lower than the best standard glass which has a tensile strength of 500,000 psi,

The final choice of a resin system is largely determined by the room-temperature properties, elevated-temperature properties, cure time and temperature, and resinhandling characteristics.

Pressure-Vessel Design: Owing to the many advantages of filament winding, many different types of pressure vessels can be suitably fabricated by filament winding. In all cases, the design of filament-wound pressure vessels must be tailored to applications.

The design of filament-wound structures differs considerably from the design of metallic structures. This is due mainly to the highly orthotropic nature of filament-wound material. Designs must be such that the filaments are only placed where they are needed, and

in such a manner that they are all uniformly stressed. Fig. 2 shows the basic geometry of a cylindrical pressure vessel that is to be wound with two different winding angles. The angle α is the low angle of winding that will cover the heads and provide longitudinal strength and the angle β is the 90-deg windings that will provide hoop strength in the cylindrical portion of the vessel.

The winding angle α is determined from the basic geometry as

$$a = \tan^{-1}\left(\frac{r_a + r_f}{L}\right) \tag{1}$$

As the winding angle α increases, a smaller portion of the end dome can be covered and larger polar bosses would be required.

Once the angle α has been determined the thickness of windings at this angle (t_{α}) can be calculated from

$$\frac{N_L}{S} = t_a \cos^2 \alpha \tag{2}$$

where N_L = longitudinal load on vessel, and S = allowable unidirectional stress level for materials being used.

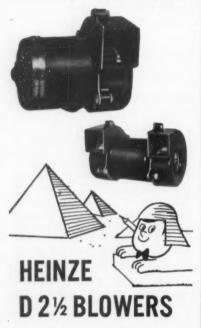
When t_a has been determined, the thickness of the 90-deg winding, t_{β} , in the cylindrical section can then be determined from

$$\frac{N_H}{S} = t_{\rho} \sin^2 \beta + t_{\alpha} \sin^2 \alpha \tag{3}$$

where N_H = the hoop load on the vessel.

The weight advantage of filament winding over metal for a cylinder is greater than for a sphere since in a spherical shape, metal is being used to its maximum efficiency. On the other hand, a sphere is one of the most inefficient shapes for filament winding. Since a filament can only be properly utilized when

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DESIGN ABSTRACTS

the loads are applied along its axis, it is desirable to design shapes for winding where this can be accomplished. This is not the case in a sphere, where the loads at any point are acting in all directions. Where shapes close to sphere are desired, filament-wound vessels can still be efficiently designed. Such a design would appear as two modified elliptical heads joined together at their major diameters. Such a wound structure could be two-thirds the weight of an equivalent volume filament-wound sphere.

Cost Considerations: The ability of filament-wound structures to compete on a cost basis with metal parts is only apparent when comparisons are made with the high strength-to-density-ratio metals such as titanium and high-tensile-strength steel. Studies have shown that when compared to titanium, filamentwound parts can be made in some instances for 10 per cent of the cost of the titanium parts. It has also been calculated that the cost of large-size filament-wound parts might be as little as 20 per cent of the cost of equivalent-size highstrength-steel parts.

Since tooling for filament-wound structures is simpler than tooling for metallic structures, a new filament-wound part can be produced in a shorter period of time than the same metal part. In addition, the number of steps in the fabrication of a filament-wound part is usually less than that required for metal parts.

ASME Paper No. 61-MD-17, "Filament-Wound Pressure Vessels," presented at the Design Engineering Conference, Detroit, May, 1961, 12 pp.

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We call the metal parts shown here Ultra-Special because they are the result of completely new cold-forming and finishing techniques. They are typical examples of how users are reducing costs by taking advantage of the strength, improved quality, close dimensions and economy of mass-producing parts by cold-forming.

In the past, the limitations of the cold-forming process forced manufacturers to accept parts which were made by other, more costly methods. Now, through extensive research and development work Townsend is cold-forming Ultra-Special items with intricate shapes and critical dimensions held to tolerances as close as .001 inch. They may be made by combining cold-heading processes with impact extrusions, special heat-treatment and coatings, to name but one of the new techniques.

The use of Townsend Ultra-Special items in your product assembly could provide the means to make better products at lower costs. Investigate by asking a Townsend field engineer to call. Write Townsend Company, Engineered Fasteners Division, P. O. Box 71-E, Ellwood City, Pa.

Townsend Company Established 1816 Engineered Fasteners Division

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2. Absence of conventional lubricants and their attendant chemical or radiation-reaction problems. 3. Absence of coulomb friction, resulting in unlimited life expectancy, coupled with stable performance characteristics. 4. Extremely low friction level for low rotational or translatory speed.

Foreseable fields of application are: 1. Extreme-temperature environments. 2. Areas where oil or grease cannot be used because of explosion or radiation problems. 3. Instruments with high rotational speed and long life requirements as anticipated in space vehicles. 4. High load or high speed, where a change in the bearing characteristics during operation cannot be tolerated. 5. Negligible rotational or translatory speed, but extremely low friction.

ASME Paper No. 61-LUBS-4, "Externally-Pressurized Gas Bearings," presented at the Lubrication Symposium, Miami, Fla., May, 1961, 4 pp.

electrical

DC Digital Voltmeters

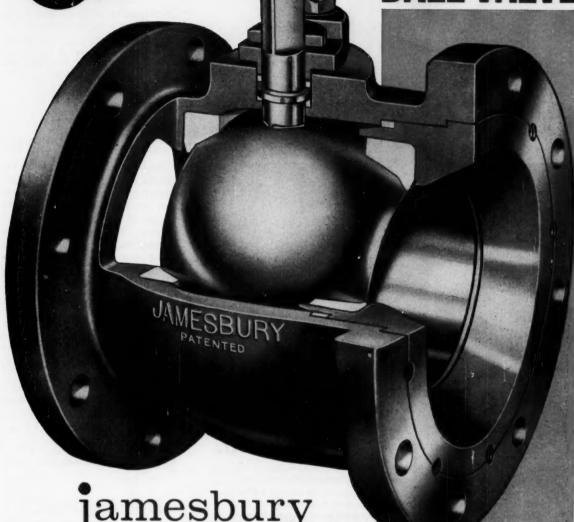
Carroll Stansbury, U. S. Dept. of Commerce, National Bureau of Standards, Washington, D. C.

Analog-to-digital converters used as instruments having as their primary function the direct visual indication of voltage in the form of decimal digits. Accuracy ratings are 1.0 per cent or higher. Provision for printer output may be included. Such instruments are essentially direct voltage instruments, but may be made suitable for alternating voltages by the addition of a converter, or may be operated as a voltage comparator or a digital ohmmeter by relatively slight modifications of the basic instrument.

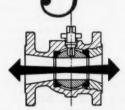
Advantages of digital voltmeters include:

- Feasibility of high accuracy.
- Superiority in reading characteristics (no skill required, no parallax, readable from a wide angle or from a distance, no confusion of scales, no interpolation).
- Extremely high input impedance (compared with deflection instruments).
- Feasibility of automatic polarity indication and range shifting.

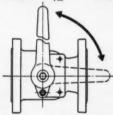
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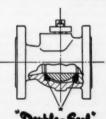
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B. Electric Reset — Type TCeF5E — Available also with 4 or 6 digits—single pulse resets all figures to zero. Speeds up to 50 imp/sec. C. Predetermining Counter—Type TCeZ4PE—Available with manual or electric reset. Double-throw switch actuated at zero. Electric-reset models available with built-in rectifier for AC operation.

D. Eight Digit Totalizer (No Reset) — Type TCe8E — also available in seven digit model. Low power requirement, Compact. Economical.

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Adaptability to code recording (including modifications providing such features as go-no-go indicators, alarms, control systems, and digital data transmission).

Adaptability to modification as an ohmmeter or voltage comparator.

AIEE Transactions Paper No. 61-721, "A General Description of DC Digital Voltmeters," presented at the AIEE Summer General Meeting, Ithaca, N. Y., June, 1961, 11 pp.

DC Motor Concepts

George A. Oberbeck, Massachusetts Institute of Technology, Cambridge, Mass.

Simplification of dc motors by reanalysis of basic principles. Directcurrent motor torque operation has been explained for many years by the use of the famous "F = Bli" formula. This approach has been accepted because the answers generated have been satisfactory. It is taught that although the equation F = Bli appears to show that the force is acting on the current carrying conductors, even though little or no field passes through the slot, actually the force is acting on the rotor iron. Tests can be run to prove this. This paper shows that the forces acting on the rotor can be quite readily analyzed and that simpler dc motors can be constructed than those in present use.

AIEE Paper No. CP 61-820, "A New DC Motor Concept with Motor Designs," presented at the AIEE Summer General Meeting, Ithaca, New York, June, 1961, 5 pp.

lubrication

Unconventional Lubricants At 1200 F in High-Speed Rolling-Contact Bearings

Donald S. Wilson, Project Engineer, Stratos Div., Fairchild Engine and Airplane Corp., Bayshore, L. I., N. Y.

Feasibility of utilizing solid lubricants in a continual injection-type system for lubricating rolling-contact bearings at temperatures of 1200 F for periods of at least 10 hr. The maximum bearing capabilities have not been explored fully but operation is possible at 25,000 to 30,000 rpm under combined radial and thrust loads of 50 lb. These results have been obtained in wrought cobalt-alloy bearings with molyb-



RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY



Technical-ities

By Fred E. Graves

Fastening of gasketed joints

The right fastener for a "flexible" joint rests on type of gasket material and its compressibility. Total preload on all the fasteners in the connection must be enough only to compress the gasket and provide sufficient additional clamping force to withstand the hydrostatic test pressure. More than this brings on a good chance of leakage, through "bowing" of the clamping plate.



Exaggerated sketch showing how too much torque tends to distort clamping plate and leads to leakage.

HYPOTHETICAL CASE

Suppose a joint is tightened with Grade 5 Hex Screws to their yield strength, and leakage develops. By going to alloy screws and tightening still further you would still get leakage. But Grade 2 Hex Screws, all torqued evenly, would no doubt solve it.

ACTUAL CASE

The fasteners on one product's flange had to withstand a 4000 pound hydrostatic pressure. But the hard asbestos gasket used took a bolt load of 28,000 pounds for sufficient compression to seal. By substituting a rubber and fibre gasket in this case, bolt load could be reduced. So could bolt size, thereby saving 73% on fasteners.

Using Hex Screws in tapped holes saves money



In the cast "coupon" shown above, the hex screws were torqued tight and removed 50 times—then torqued to failure. Note in the cutaway that the casting's threads are still perfect with no sign of stripping. It was the screws which broke—a clear demonstration that castings fastened with hex screws will suffer no thread damage during repeated disassemblies.

TWOFOLD BENEFIT

When there are no space clearance problems or other special requirements, using studs of 1-inch diameter or smaller often penalizes the user. First, in direct costs, since the more economical hex head screws will do the job to specification. And second, in production costs, since studs require that tapped holes have an *interference* thread fit, which in turn results in slow, "selective" assembly to determine properly

mated threads. Hex screws need only a clearance fit, assemble faster.

ACTUAL EXAMPLE

In one of his surveys of fastenings used by one company, the RB&W engineer pointed out that over 250 stud fastenings were being used in a large refrigeration unit. The same number of hex screws, costing \$8.45, saved \$22 over the studs and nuts. Annually, the total would be \$7,800 on the production run of this unit.

Not to be overlooked either was the tangible saving on the less critical tapping job required.

RB&W offers its help on your specific fastener problems, or an overall survey of your fastener usage. Contact Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

Plants at: Port Chester, N.Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales effices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.



Mr. A. A. Lindberg, Design Engineer, Moore Special Tool Co., Inc. states: "On our Model 11/2 Jig Borer...

General Electric Polydyne® Drives Help Us Maintain 0.000070" Accuracy"

"Efficient control of vibration is the reason that the majority of our Model 11/2 jig borers are equipped with General Electric Polydyne drives. Competitive drives have never fully solved this problem," states A. A. Lindberg, Design Engineer for Moore Special Tool Co., Bridgeport, Connecticut.

"Moore tests each Polydyne drive on a specially constructed bracket," continued Mr. Lindberg. "Vibration readings are taken at three points, and every Polydyne drive tested has been under the vibration limit of 0.001 inch and virtually free of operating noise.

"Another reason that our Model 11/2 has proved

popular is that the Polydyne drive gives an infinite number of operating speeds with just a simple adjustment of the dial to the desired rate."

When your application requires low-cost adjustable speed combined with reliability and ease of maintenance, investigate G-E Polydyne drives. Your General Electric Sales Engineer has full details. Or, write for bulletin GEA-6806, Section 854-06, General Electric Company, Schenectady 5, N. Y.

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denum disulfide.

The degree of bearing wear and smoothness of operation are dependent upon the type and characteristics of the lubricant film formed on the bearing-contact surfaces. The formation of such a film is a function of both the lubricant and the bearing material, the degree of filming being dependent upon the affinity of the former for the latter.

Investigations are continuing to extend the operational range of solid lubricants from 70 to 1200 F in actual bearing evaluations. Additional solid lubricants are also being screened and it appears that combinations and mixtures of solid lubricants, when effectively applied, will permit operation of rolling-contact bearings over a temperature range of 70 to 1200 F at speeds to 30,000 rpm for periods of at least 10 hr.

ASME Paper No. 61-LUBS-9, "Evaluation of Unconventional Lubricants at 1200 F in High-Speed Rolling-Contact Bearings." presented at the Lubrication Symposium, Miami, Fla., May, 1961, 8 pp.

processes

Using Adhesives For Metal Bonding

H. R. Butzlaff and K. F. Charter, A. O. Smith Corp., Milwaukee, Wis.

The factors leading to the selection of adhesives for bonding metal, and the limitations of these adhesives. Favorable characteristics include:

- In adhesive bonds the load is more equally distributed than in other types of joints. Smoother contours are produced; gaps and voids are minimized. This minimizes stress concentrations and, in turn, may produce better fatigue properties and allow a reduction in metal thickness.
- Adhesives are elastic enough to absorb stresses created by flexing and differences in coefficients of expansion.
- Adhesives can join dissimilar metals and materials and, in some cases, are the only practical method of joining.
- 4. Bonded joints damp vibrations.
- Cost savings can sometimes be affected by eliminating fastener costs, and reducing metal forming and machining operations.
- Large areas can be bonded in a relatively short time.



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Originally, a casting requiring heavy cutting, a tube, a web plate and 3 rivets were required. Now a one-piece brass cored forging is polished and plated without machining—and the blanked out web provides the cap.

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1	less assembly required
	thinner walls or sections
	better appearance
	multiple coring
1	lower cost plating
1	less scrap/rejects

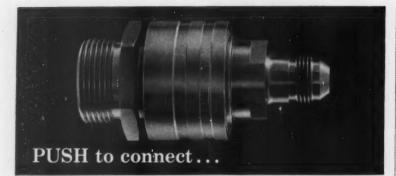
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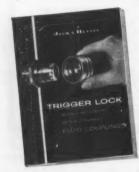
New, no-air inclusion TRIGGER LOCK FLUID COUPLINGS

give instant seal, quick disconnect, long life

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Designed for a wide range of fluid systems from hydraulic oils through exotic fuels, this new J&H TRIGGER LOCK Coupling exhibits exceptionally high pressure capabilities and very low pressure drops. Its straight-line axial action and compact design save space and weight. It is easily adapted for remote operation. Its exclusive locking pin design eliminates "brinelling" which shortens the life of usual ball-type mechanisms.

TRIGGER LOCK Couplings are supplied in standard sizes from ¼" through 1¼", with no limit on special designs. Write for catalog C-2101. Jack & Heintz, A Division of the Siegler Corporation, P. O. Box 6719, Cleveland 1, Ohio.





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DESIGN ABSTRACTS

- A general reduction in weight can be accomplished through reduced metal thickness and elimination of fasteners.
- The adhesive bond can provide electrical insulation and thus minimize galvanic corrosion.
- Bonding does not embrittle aluminum or magnesium or tend to warp steel as welding may do.
- Adhesives eliminate the need for high temperatures as used in welding.
- Adhesive bonds leave good surfaces for organic coatings.
- 12. Adhesives provide a sealing action in addition to bonding.

ASME Paper No. 61-MD-14, "Factors in Joint Design Using Adhesives for Metal Bonding," presented at the Design Engineering Conference, Detroit, May 1961, 9 pp.

Shearforming 7075 Aluminum

C. E. Howle and Frank Jacobs, Temco Missile & Electronics Co.

Aluminum alloy 7075 shearformed on a production basis. The alloy can be readily worked in the "O" condition at room temperature. If the part is to be used in the "T-6" condition, the final shearform operation should be performed in the "W" condition to reduce distortion of the part during solution heat treat. When shearforming in the "W" condition, the part should be heated to approximately 300 F.

SAE Paper No. 340B, "Shearforming 7075 Aluminum," Aeronautic Meeting, New York, April, 1961, 5 pp.

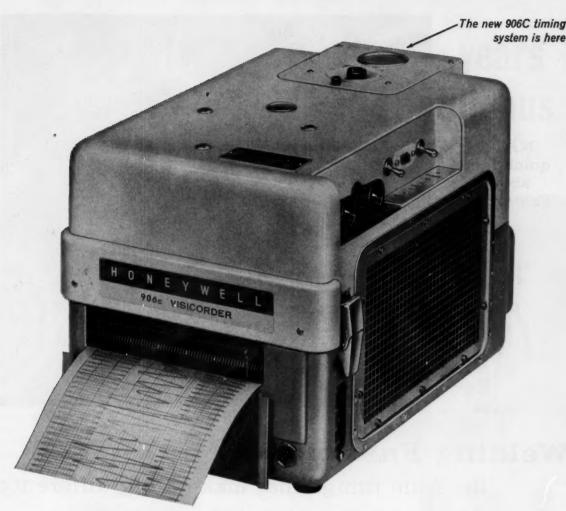
techniques

Approximate Representation Of An Irregular Curve With Linear Segments

S. G. S. Shiva, Bangalore, India.

Theoretical aspects of the approximate representation of an irregular curve with linear segments and applications of such a representation. An irregular curve is one which, on easy inspection, cannot be expressed with a compact equation.

The approximate representation of irregular curves through a series of step functions has been well known. But, to get a fair approximation, the size of the subinterval has to be small. It may be safely said that in a situation, where both



What's different about the NEW 906C VISICORDER OSCILLOGRAPH?

At first glance you may see no difference at all. Just the same functional lines and compact size that you have come to recognize in the Visicorder.

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But the 906C has a new feature you can see, (look carefully at the back of the case) and one that represents still another breakthrough; a built-in flash tube timing system which not only generates its own time base, but which can also be triggered externally. You can, in other words, use the 906C's

timing system to record time lines simultaneously with data. Or you can trigger the timing circuit externally—either by supplying a pulsing voltage of only +10v into 20K ohms impedance, or simply by causing impedance to drop to 100 ohms or less through shorting-out or other means.

Thus your "time" signal may actually be an event marker related to shaft rotation, belt movement, or any other effect which might be more conveniently fed to the timing circuit than to a galvanometer.

(Owners of Visicorders 906, 906A, and 906B will be glad to know that only a *field-change* is necessary to economically and easily add this timing system to their instruments).

Write today for full information on the brand-new 906C Visicorder. Ask for Catalog HC-906C. Or call us at SKyline 6-3681, Direct Distance Dialing Code 303.

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We might just mention, too, that we happen to be particularly adept at developing Special Fasteners for welding. They can often be designed to do a better job and save money for you. Ask us about your applications.

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the "linear-segment" and "stepfunction" methods are applicable, the former gives far better approximation with far fewer subintervals in a given total period of time. The "linear-segment" method, applied in this paper only to functions of finite duration, can be extended to functions of infinite duration also so far as the representation of the function is concerned. But as regards the question of the generation of a function or conversion of one into another, this approach is limited to functions of finite duration only, as it involves time delay factors.

AIEE Transactions Paper No. 61-804, "A Note on the Approximate Representation of a Curve with Linear Segments," presented at the AIEE Summer General Meeting, Ithaca, N. Y., June, 1961, 8 pp.

Maximization and Minimization Of Complicated Functions

Nathan S. Bromberg, Massachusetts Institute of Technology, Cambridge, Mass.

Review and appraisal of various existing methods of finding singular points, (maxima, minima, or saddle points), in functions of many variables. This paper is limited to methods involving a search procedure rather than a formal analytical technique. These methods are useful whenever an optimum condition is required of a system too complex for conventional techniques.

These methods are most valuable when the number of variables is large, and the functions are nonlinear. Several families of solutions are usually admissible, since most of these problems are not completely constrained.

AIEE Transactions Paper No. 61-803, "Maximization and Minimization of Complicated Multivariable Functions," presented at the AIEE Summer General Meeting, Ithaca, N. Y., June, 1961, 15 pp.

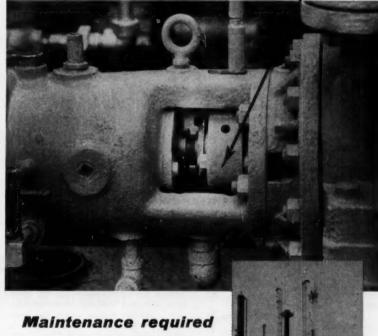
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See our File in SWEETS Design Catalog Section 8e

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Helpful Literature for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Range Drives

Application of Varidyne ac controlled speed systems to range drives is discussed in Brochure F-2028. Describes how the frequency-control of speeds in ac squirrel-cage motors permits motors to start, stop, accelerate to full speed, and accept speed adjustment while running. Brochure provides schematics of Varidyne applications on range drives for both tension control, and for tensionless operation. 6 pages. U. S. Electrical Motors Inc., P. O. Box 2058 Terminal Annex, Los Angeles 54, Calif.

Circle 501 on Page 19

Silicon Rectifiers

More than 150 different silicon diffused rectifiers are described in a new catalog. Illustrations and complete mechanical and electrical specifications cover units ranging from 50 to 600 v peak inverse voltage and from 250 ma to 22 amp. Lead-mounted types, stud-mounted types of standard and reverse polarity construction, and ceramic-insulated study types, as well as rectifier mounting hardware for stud units, are detailed. 6 pages. Semiconductor Div., Raytheon Co., 215 First Ave., Needham, Mass.

Circle 502 on Page 19

Liquid-Level-Gage Valves

Two catalogs Data Units 397 and 398, illustrate and describe features, styles, sizes, and construction details of union bonnet and screwed bonnet liquid-levelgage valves. Included are roughing drawings and detailed tables of standard and optional features. 8 pages. Jerguson Gage & Valve Co., 80 Adams St., Burlington, Mass.

Circle 503 on Page 19

Thermometers and Gages

Bulletin 282 reviews ten standard models of thermometers available in dial sizes from 1 to 5 in., in scale ranges from -150 to +1000 F. Photographs and cross-sectional schematic diagrams illustrate all models, supplemented by a capsule digest and a comparative Fahrenheit and Centigrade temperature-range chart. Also presented are two high-pressure gages. 4 pages. Rochester Plant, Controls Div., American-Standard, 100 Rockwood St., Rochester, N. Y.

Circle 504 on Page 19

Rotation-Analyzing System

Rotan system, described in Bulletin A-2049, consists of an angle-encoding

transducer and a rotational analyzer. Designed to study rotation-associated phenomena in machinery, units adapt an oscilloscope to provide horizontal trace deflection proportional to angular displacement of a rotating shaft. 4 pages. Tectronix Inc., P. O. Box 500, Beaverton, Oree.

Circle 505 on Page 19

Centrifugal Pumps

Type GP close-coupled, end-suction centrifugal pumps are covered in Bulletin 117 PKG. Cross-sectional views, construction specifications, performance charts, and dimension data illustrate the outstanding features of the units. Pumps range in capacities to 400 gpm and heads to 150 ft. 4 pages. Aurora Pump Div., New York Air Brake Co., Aurora, Ill.

Circle 506 on Page 19

Designing with Titanium

Potentials of sintered titanium in modern design are covered in "Designing with Clevite Sintered Titanium." Bulletin 100 presents basic design information and properties for the titanium, including tolerances, processing and specifying data, and technical service information. Another section details the benefits of sintered titanium as a design material. Mechanical Research Div., Clevite Corp., 540 E. 105th St., Cleveland 8, Ohio

Circle 507 on Page 19

Lock-Washer Selection

Basic guide for lock-washer applications includes a wide variety of types and styles. Through use of pictures, text, and line drawings, pocket-sized booklet AS-105 describes the correct washer for general use, for spanning oversize holes, for flat or oval-head screws, for heavy nuts and bolts, for grommet-retainer use, for extreme fastening stresses, and for special problems. 12 pages. Shakeproof Div., Illinois Tool Works, St. Charles Road, Elgin, Ill.

Circle 508 on Page 19

Hydraulic Products

Miniaturized Oil-Dyne hydraulic pump, in 96 basic models, is fully described and illustrated in Catalog 21. Other products listed are hand pumps, standard and heavy-duty pressure switches, relief valves, gages, and a full line of cylinders with $\frac{1}{2}$ to 4-in. bore sizes. Section is devoted to accessories for use with the equipment, including tube and pipe fittings, hose, couplings, filters, strainers,

various types of valves, heat exchangers, timers, accumulators, and electrical accessories. 76 pages. Oil-Dyne Inc., 2115 P W. Marquette Rd., Chicago 36, Ill.

Circle 509 on Page 19

Plugs, Chip Detectors, Valves

Magnetic plugs can be installed in assemblies with moving parts in an oil bath or system, and in products involving a hydraulic system. Catalog MPC-61 shows where the units can be used, and what they do. Products covered included magnetic plugs, chip detectors, self-closing valves, and Dri-seal pipe plugs. All specifications are given, and list of tools is provided. 26 pages. Lisle Corp., Clarinda, Iowa.

Circle 510 on Page 19

Rotating Seal

Type 605 rotating metal bellows seal is for use in pumps, compressors, agitators, and mixers. It is described in Bulletin M102, along with several typical applications. Operating and design data are also included, and advantages of the seal are pointed up. 4 pages. Sealol Inc., Providence, R. I.

Circle 511 on Page 19

Patterned Steel

Sharonart surface-rolled patterns are available in stainless, carbon, and coated steels. New handbook gives complete information concerning sizes, pattern designs and identification numbers, actual and suggested product uses, and methods of fabricating the patterns. Brochure depicts applications in automotive, architectural, appliance, and business-equipment fields. Information on finishing, tooling, and fabrication is also included. 20 pages. Sharon Steel Corp., Sharon, Pa.

Cricle 512 on Page 19

Bellows, Bellows Assemblies

Two forms of metallic bellows are hydraulically formed and welded. Catalog 610 covers both types, giving data on Formweld and Formflex units. Material on when and where to use the two types is included, with tables listing all specifications. Other material includes conversion equations, altitude-pressure temperature, temperature conversion table, and a large, fold-out graph on vapor pressure-temperature relationships of charging liquids. 20 pages. Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., Milford, Conn.

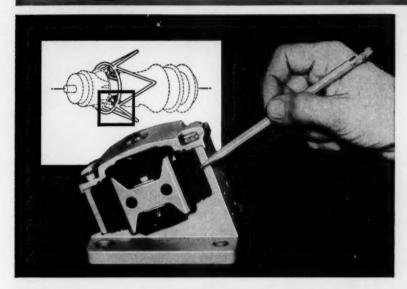
Circle 513 on Page 19



VIBRATION NOTES

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New MB Synthetic Coating Solves Tough Engine Mount Problem

How do you isolate the vibration of an aircraft engine when none of the available engine mount materials can meet the specifications required? MB engineers had to solve this problem in designing mounts for the turboprop engines of the Grumman Mohawk observation plane. They did it by "manufacturing" a new isolation material...natural rubber covered with a thin film of Iso-Kote, a unique elastomeric coating.

Vibration isolators for the turboprop engine had to withstand high gyroscopic loads; were limited in size by dimensions of engine mounting pad and nacelle structure; and had to be resistant to di-ester lubricant, Turbo Oil #15. Mechanical requirements left no room for compromise. Only natural rubber could meet the rigid specifications of strength, weight, space limitations and low temperature flexibility.

However, natural rubber deteriorates upon exposure for any length of time to the di-ester Turbo Oil. So, unfortunately, do those synthetics generally considered for vibration isolation.

The application of a thin coating of Iso-Kote to natural rubber provided complete resistance against the corrosion and degradation effects of the di-ester lubricant. The coating has excellent adherence and, of particular importance in vibration applications, has the same elongation as natural rubber.

The successful development of this unique engine mount material, combining the mechanical properties of natural rubber and the chemical properties of Iso-Kote, represents another MB achievement in vibration engineering.

MB engineers will be glad to assist you in solving your vibration problems. Send today for our Vibration Mount Catalog. Write to Isomode Division, MB Electronics, P.O. Box 1825, New Haven 8, Conn.

Fundamental Motions of Vibrating Bodies

Isomode is the registered trademark of MB's regular line of vibration mounts. The name is derived from the word "isolation" and from the six "modes" of motion to which all rigid bodies are subject.

In actual practice, vibration is seldom confined to a simple, single motion. If it were, control would become a fairly simple matter. But even a rigid body has six degrees of freedom in space as illustrated here.

Complex structures have even more modes of motion. These may involve the relative motion of various rigid bodies or distortion of flexible bodies.

In general, vibration problems lie in the six fundamental motions. Any of these modes may be excited by vibratory forces. To design successful vibration control, you must consider all modes and the excitations to be expected.

1. Translation along longitudinal axis



2. Translation along



3. Translation along vertical axis



4. Rotation about longitudinal axis (roll)



5. Rotation about lateral axis (pitch)



6. Rotation about vertical axis (yaw)



Electric Motors

Abridged Catalog Bulletin BMC 914 provides data on ½ to 600-hp electric motors. Construction features and general specifications are given for all motors, and a page of helpful information on selection of motors is included. Dimensional data are given in line drawings and tables. 12 pages. Brook Motor Corp., 3302-04 W. Peterson Ave., Chicago 45, III.

Circle 514 on Page 19

Miniature Check Valves

Valves for use in fuel, hydraulic, and chemical systems are described in Catalog 60B. Several tables list flow characteristics, burst pressure, flow rate in tubing, and wrench torque for tightening. Each valve is shown in a photograph, and dimensional drawings and tables present all specifications. 30 pages. Spartan Mfg. Corp., 445 Saw Mill River Rd., Yonkers, N. Y.

Circle 515 on Page 19

Drive Tensioner

Hi-Q Tensioners can be mounted on the floor, on the wall or vertical surface of machine, and on the shaft. Catalog TR-1 shows how the tensioners improve drive performance and extend drive life. Four types of idlers are shown, and nine main features of the tensioners are pointed out in an exploded model. Selection tables are included for the four idler types. 4 pages. Maurey Mfg. Corp., 2907-23 S. Wabash Ave., Chicago 16, Ill.

Self-Threading Nuts

Advantages of Palnut self-threading nuts include elimination of the threading operation, and ability to assemble on off-angle studs. Catalog 585A lists these and other advantages, and shows by diagrams how the units operate. Dimensions and torque-tensile data are included for washer, regular, and acorn types. 8 pages. Palnut Co., Div., United-Carr Fastener Corp., Glen Road, Mountainside, N. I.

Circle 517 on Page 19

Shear Pin Sprockets

Rex stock shear pin sprockets which provide positive protection of equipment against destructive overloads consist of a sprocket, hub, shear pin, and retaining ring. Bulletin 6119P presents easy-to-follow selection aids, drawings, and complete specifications. Included are large line drawings and tables to facilitate the selection of sprockets. 8 pages. Chain Belt Co., Milwaukee 1, Wis.

Circle 518 on Page 19

Small Pumps

Type SRA pumps are small, special-application units with capacities to 50 gpm for pressures to 350 psig. Bulletin 150.4 illustrates and describes the rotor-stator progressing-cavity principle, capable of handling abrasives or suspended

solids without damage. Other sections provide a rating chart for all sizes when operated at various speeds and discharge pressures, dimension drawings and tables, engineering drawings, and parts lists. Moyno Pump Div., Robbins & Myers Inc., Springfield, Ohio.

Circle 519 on Page 19

Antifriction Bearing Screw

Roton bearing screw converts rotary force and motion to linear force and motion, and vice versa. New catalog provides data on basic operation principles, on the various types of units, on design advantages, and on typical applications. Additional data are included on selection and ordering, and specification sheets are provided. About 22 pages. Anderson Co., Gary 40, Ind.

Circle 520 on Page 19

Plastic Protectors

High impact resistance and resistance to oils, acids, alkalies, and greases are qualities of threaded acetate-plastic protectors for male and female machine screws and pipe threads. Bulletin 6104-AP provides all dimensional and pricing data for machine-screw caps and plugs, pipe plugs and caps, and propeller shaft caps. 8 pages. S. S. White Plastics Div., 10 E. 40th St., New York 16, N. Y.

Circle 521 on Page 19

Right-Angle Template Kits

New template kit and catalog permit selection of the unit with configuration, rpm, horsepower, and torque ratings to suit the application. Catalog lists all variations of the 18 basic models. Crown Gear Co., 320 Park Ave., Worcester 10, Mass

Circle 522 on Page 19

Self-Lubricated Bearings

Lube-Align bearings combine a selflubricating, spherical bronze bearing in an aluminum, die-cast housing. New bulletin points out the features of the units, and gives specifications and dimensional data. Engineering information and selection data are also included. 8 pages. Bronze Bearings Inc., 3553 W. Addison St., Chicago 18, Ill.

Circle 523 on Page 19

Wire Markers

E-Z-Code self-laminating markers resist oil, grease, chemicals, and other foreign matter. Booklet SL4-3 shows how the units, consisting of a precoded marker and partly transparent wrap, are used. List of markers is also included. 4 pages. Westline Products Div., Western Lithograph Co., 600 E. Second St., Los Angeles 54, Calif.

Circle 524 on Page 19

Multipurpose Fastener

Nylatch can be used in metal, wood, and synthetics, wherever fast, simple latching is needed. Bulletin lists 14 advantages of the fastener, gives test results and technical data, and shows how to install the latch. Some typical uses are also included. 8 pages. Hartwell Corp., 9035 Venice Blvd., Los Angeies 34, Calif.

Circle 525 on Page 19

Pressure Snubbers

New catalog covers industrial porousmetal pressure snubbers, available for pressure-instrument protection. Standard dimensions, engineering data, applications, and advantages are given. Units are also shown with tubing connections. 4 pages. Chemiquip Co., 36 E. 10th St., New York 3, N. Y.

Circle 526 on Page 19

Control Instruments

Seventh Edition condensed catalog contains basic information on standard instruments for analog computing, control, flow, liquid level and specific gravity, pneumatic relays, pressure, temperature transmitters, and valve positioners. Data includes, for each instrument, ranges, model numbers, and materials available from stock. Each unit is pictured, and text gives uses, modifications, and specifications. 26 pages. Moore Products Co., H and Lycoming Streets, Philadelphia 24, Pa.

Circle 527 on Page 19

Pump Drives

Brochure F-2002 is indexed so that pump motors and drives can be identified as to construction type, enclosure, thrust, and company type designation. Condensed specification data include ratings, dimensions, thrust capacities in pounds, speeds, frame sizes, ratios and selection charts for gear drives, and electrical specification material. Descriptive pages provide cutaways, cross-sections, and detail drawings as well as text. 20 pages. U. S. Electrical Motors Inc., P. O. Box 2058, Terminal Annex, Los Angeles 54, Calif.

Circle 528 on Page 19

Sleeve Bearings

Two new types of self-aligning and self-lubricating sleeve bearings in flanged and pillow-block types solve application problems of temperatures to 1000 F, corrosive and contaminating conditions, underwater operations, and lubricating and noise problems. Folder 2823 describes the benefits and features of the new units, and lists application, selection, and dimensional data. Link-Belt Co., Dept. PR, Prudential Plaza, Chicago I. III.

Circle 529 on Page 19

ABS Thermoplastic Resin

Available in 11 formulations, Cycolac plastic is suited for a wide range of applications, many of which are shown in Form 10240. Advantages of the material are pointed out, and a large chart provides data on typical properties of the various grades. 8 pages. Marbon Chemical Div., Borg-Warner Corp., Washington, W. Va.

Circle 530 on Page 19



PAR Process thinking removed the IF ... saved 2 operations for DeVilbiss

DeVilbiss had good reason for wanting to replace machine screws as the means of fastening reed type intake valves in the popular TUFFY Paint Spray Compressor. Tapping was needed; an extra operation. Bulky screw heads required making recesses in an adjoining plate; another extra step. And, machine screws could be loosened by the vibrating valve.

Riveting would overcome all the problems, cut costs and increase assembly rate by 20 percent. BUT how could a sufficiently thin, flat rivet head be had, and at reasonable cost?

An ingenious answer came from the TRS man applying his PAR Process approach to the problem. "We'll design special jaws and a driver, and work out the feeding details so that you can feed standard oval head rivets and flatten them in the setting operation."

It was successful! From the simplified process, DeVilbiss gets a neat saving, faster assembly and stronger fastenings that are better sealed against leakage. And, of course, rivets cost less to buy.

FIND OUT what the PAR Process can save you

The PAR Process starts with a search by your TRS man for ways to eliminate or simplify and speed up steps in assembly. It is made effective by specially organized TRS procedures, backed by unique TRS developments in rivets and riveting machines.

The PAR Process may bring you better integration and greater automation of assembly operations, or even a cost-cutting change in basic assembly method. Ask for a check of your operations . . . it can be worth dollars to you.

Don't Buy Riveting Machines until you learn how the TRS PAR process revolutionizes riveting



TUBULAR RIVET & STUD COMPANY

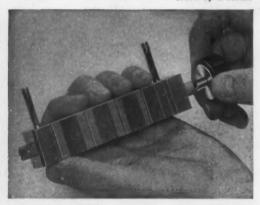
QUINCY 70, MASSACHUSETTS • TRS SALES OFFICES: Atlanta • Buffalo • Charlotte • Chicago Cleveland • Dallas • Detroit • Hartford • Indianapolis • Los Angeles • New York Philadelphia • Pittsfield • Quincy • St. Louis • Seattle. WAREHOUSE IN CHICAGO See "Yellow Pages" for phone numbers.

If it's a Tubular Rivet TRS makes it . . . and Better



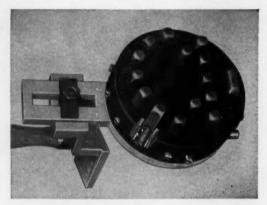
Practical Design Tips

No. 5 of a series

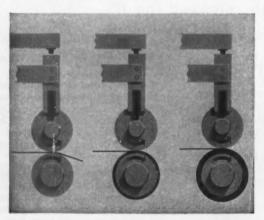


TORQUE APPLIED TO ASSEMBLE PRECISION GAGE BLOCKS is limited by this modified Vlier Torque Thumb Screw. Ground screw point mates with assembly screw; prevents overtightening with resultant damage to blocks. Torque Screws are available in four types, many thread sizes, lengths and end pressures.

Cost conscious product designers are finding new uses for Vlier products in all types of original equipment. Simple applications such as shown below are saving hundreds of dollars. Examine your drawings and products today and see where these inexpensive, off-the-shelf parts can lower your costs.



SPRING-LOADED BALL PLUNGERS HOLD MARKING STAMPS IN POSITION, yet allow them to move freely when struck. Ball Plungers are threaded into metal inserts molded in rubber. Binding action of rubber prevents plungers backing off. Plungers come in six models; sizes from #4-48x3/16. to #5/8-11x1; 18 end pressures.



LIMIT SWITCHES ON THIS TEXTILE DRAWING FRAME ARE PROTECTED by Vlier Spring Plungers. Bunching of broken threads causes rolls to lift, actuating limit switches which automatically shut off the machine. Plungers permit normal operation of the switches, but limit over-travel of switch actuating arm. Spring Plungers are available in four models, 50 sizes, various end pressures.



FREE IDEA BOOKLET! This informative 16-page booklet shows how other original equipment manufacturers are profiting from the use of standard Vlier parts. It may suggest ways you can save, so write for your copy today.



A subsidiary of Barry Wright Corporation 8900 Santa Monica Blvd. • Los Angeles 46, California

Miniature Stake Nuts

Floating and nonfloating stake nuts, easily and quickly installed, provide high holding power. They are described and pictured in new bulletin which incorporates an enlarged cutaway view of one of the units in the material. Features are pointed out, and all specifications are included. 6 pages. Kaylock Div., Kaynar Mfg. Co. Inc., Box 2001, Terminal Annex, Los Angeles 54, Calif.

Circle 531 on Page 19

Belting Fabric

Technical Service Bulletin, "XL In Belting Fabrics," provides full information on Avisco XL rayon used for industrial applications in conveyor and transmission belting fabrics. Charts and graphs point out the advantages of the rayon in engineered fabrics. Minimum tensile specifications and fatigue results for both XL rayon and cotton constructions are given and compared. Work efficiency, illustrated by stress-strain diagrams, and conclusions summarizing the features of the rayon, are also included. 12 pages. American Viscose Corp., 350 Fifth Ave., New York I, N. Y.

Circle 532 on Page 19

Valves, Cylinders, Pumps

Tube-O-Matic control valve contains no poppets, spools, or sliding seats. It is one of many valves, cylinders, pumps, accessories, and controls listed in Bulletin 91051. Short descriptions and photographs are provided for each unit covered. 6 pages. Airmatic Valve Inc., 7313 Associate Ave., Cleveland 9, Ohio.

Circle 533 on Page 19

Nuts and Bolts

Stover lock nut is a one-piece, all-metal, prevailing torque unit. It is pictured and described fully in new Bulletin 953, containing complete dimensional data. Also included are plug nuts and hook knurl bolts. 8 pages. Lamson & Sessions Co., 5000 Tiedeman Rd., Cleveland 9, Ohio.

Circle 534 on Page 19

Variable-Displacement Pump

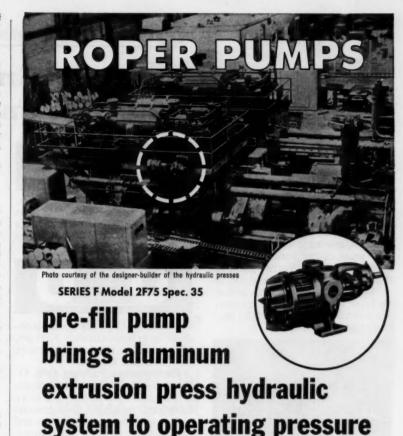
Catalog WO-7 provides information on new WO-7 high pressure, piston-type pump. It points out the design features of the unit, and lists several applications. 4 pages. Hydraulic and Pneumatic Sales, Weatherhead Co., 300 E. 131st St., Cleveland 8. Ohio.

Circle 535 on Page 19

Roller Chain

Top plates of new flat-top conveyor roller chain, described in Bulletin 9, are Delrin. Bulletin includes prices, sizes, and full description of the roller chain which operates continuously with minimum of wear and without breakage. 4 pages. Acme Chain Corp., 821 Main St., Holyoke, Mass.

Circle 536 on Page 19



1-300 GPM CAPACITIES . OPERATING PRESSURES TO 300 PSI

The hydraulic system of this self-contained oil hydraulic four column aluminum extrusion press, designed and built by Birdsboro Corporation, relies on a Roper Series F pre-fill pump to fill the hydraulic cylinder with oil to operating pressure. The Roper pump was installed as original equipment when the press went into operation five years ago. The 200 SSU viscosity oil is pumped at the rate of 84 gpm and pressure of 125 psi as pump operates at 1140 rpm. Series F pumps are specially designed for transfer of clean liquids in applications such as hydraulic power pressure lubrication or fuel oil transfer. Pump has arrangement for circulation of oil through bearings to control their operating temperature.

INSIDE STORY OF SERIES F

- PUMPING GEARS: pair of six-toothed helical gears of heat-treated steel, accurately finished to keep pump running smoothly, quietly.
- BEARINGS: two bronze, flange-type bearings on each side give ample support to pumping elements which are self-cooled and lubricated by liquid being pumped.
- BACKPLATE: carries pipe connections, designed to permit removal of internal parts without disturbing piping or drive.

For information about your specific pump needs, contact your nearest Roper dealer

Send for "How to Solve Pumping Problems" booklet



Dependable pumps since 1857

COMMERCE, GEORGIA

tips on selecting packing materials and forms

The all-purpose hydraulic-pneumatic packing—if one can be found—is a distant dream. A multi-purpose cup introduced by Houghton last year brought us closer but varying conditions still call for materials and forms with special characteristics.

To help you to simplify packing selection, at least to a degree, we list here some of the variables — and limitations—of different packing styles and materials. Houghton is uniquely equipped to do this in that we favor no one type over another. We make them all—and a full range of hydraulic fluids as well.



Fabricated Packings (V's, U's, Cups, Flange, Diaphragms). These fabric-and-rubber packings operate over a wide temperature area from -40°F. to 600°F., depending on the material.

MATERIAL	MEDIUM	MAX. TEMP.
Duck & Neoprene	Water, oil,	250°F.
Duck & Butyl	Phosphate esters	250°F.
Asbestos & Neoprene	Oils, air	300°F.
Asbestos & Rubber	Steam	600°F.

Fabricated Packings are used chiefly on heavy industrial equipment with common metal finishes and average machine clearances. They operate successfully in alkali and acid conditions and the V's at pressures up to 10,000 psi.

V-Packings — the most popular and generally the most efficient fabricated type—are installed in sets to meet varying pressures:

0-500 psi.	3 packings/set
500-3000 psi.	4 packings/set
3000-5000 psi.	5 packings/set
5000-10,000 psi.	6 packings/set



U-Packings are never used in sets. Maximum operating pressure is slightly under 3000 psi., and their chief advantage is low friction and small space requirements.



Fabricated Cup Packings can withstand up to approximately 3000 psi. and are used in a variety of hydraulic and pneumatic systems.

Homogeneous Packings (V's, O-Rings, U-Cups, Cups, Diaphragms, Gaskets, Moulded Parts). Unlike fabricated packings, homogeneous seals require fine metal finishes and minimum machined clearances. Temperature range is from sub-zero (usually -65°F.) to 250°F. (Viton: 450°F.) and pressure is generally limited to 5000 psi. for V's and O-Rings.

Homogeneous "V" packings are used in sets with adapters to meet varying pressures:

0-500 psi.	3 packings
500-1500 psi.	4 packings
1500-3000 psi.	5 packings
3000-5000 psi.	6 packings

Homogeneous U-Cups are basically low pressure packings (less than 1500 psi.) and are not recommended for pressures above 3000 psi., or temperatures above 250°F. (Viton: 450°F.).



Homogeneous O-Rings are used primarily for reciprocating motion. They can be used for oscillating and rotary motion only at low speeds and pressures. A back-up washer is recommended for pressures above 1500 psi. Maximum operating temperature is about 250°F. (Viton: 450°F.).



Leather Packings (V's, U's, Cups, Flange). Leather packings are ideal for heavy duty applications where long wear is a "must". Operating temperatures, however, should not exceed 200°F. and leather should not be subjected to strong acid or alkali solutions.

The great strength of the fiber structure and anti-extrusion properties of leather is indicated by leather U's which have held pressures up to 140,000 psi.



Sets of Leather V's will outlast and outperform all other types and can withstand pressures over 50,000 psi.

0-500 psi.	3 packings
500-5000 psi.	4 packings
5000-10,000 psi.	5 packings
10,000 and over	6 packings

The Houghton Line of VIX-SYN homogeneous and fabricated packings and VIM leather packings will meet most any combination of critical and variable conditions that dictate packing selection. Detailed information on the selection, design and performance of all types are available through your Houghton representative. Call him or write: E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

Houghton

INDUSTRY'S PARTNER IN PRODUCTION

Glass-Sealed Resistors

RX deposited carbon resistors and Hi-Meg carbon-coated-element units are discussed in Bulletin 3140-61. Resistors achieve a high degree of accuracy and stability, and operate at high level over extended periods. Complete descriptive information is included, as well as performance curves and significant tabular data. Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle 537 on Page 19

Electric Valve

Series B miniature valve has 1 in. diam, is 2 in. high, and weighs 5 oz. It is covered in Bulletin D15.1.1, which includes two enlarged cutaway views, energized and de-energized. List of specifications, dimensions, and charts of flow characteristics complete the material. 4 pages. Skinner Electric Valve Div., Skinner Precision Industries Inc., New Britain, Conn.

Circle 538 on Page 19

Electronic Tuning Set

Four applications using digital time signals to co-ordinate remote equipment in complex instrumentation and data-processing systems, described in spiral-bound brochure, include: Airborne reconnaissance with automatic data logging; ground timing system for test ranges and missile sites; data processing with time compression and expansion features; ground-support equipment for performance checkout. System components are shown, and six types of timing wave-train formats are illustrated. 18 pages. Hallicrafters Co., 4401 W. Fifth Ave., Chicago 24, Ill.

Circle 539 on Page 19

Recorder-Reproducer

GL-2510 recorder-reproducer operates on continuous magnetic-tape loops of variable lengths to 75 ft at tape speeds from 1% through 60 ips. The self-contained system with 14 analog, FM, or PDM amplifiers, precision-frequency power supply, and ventilating blower unit housed in a single steel cabinet is described in Bulletin 2510. List of specifications is included. 4 pages. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Circle 540 on Page 19

Control Switches

Low-pressure switches, vacuum switches, differential-pressure switches, air-flow interlock switches, water-flow interlock switches, flow meters, manometers, and air-filter gages have applications in the electronic, machine, and processing industries. New catalog contains complete design information, specifications, and dimensional diagrams, including photographs and line drawings. 30 pages. Henry G. Dietz Co. Inc., 12-16 Astoria Blvd., Long Island City 2, N. Y.

Circle 541 on Page 19



They are used singly, in tandem and in multiple jacking arrangements to position loads weighing from a few hundred pounds to as much as several hundred tons.

When connected in tandem or groups of four, six or more, these jacks always raise or lower in exact unison regardless of load distribution. They are also used for application of pressure, to push or pull and as linear actuators.

Duff-Norton Worm Gear Jacks are self-locking and will hold heavy loads in position indefinitely without any creep. Since there is no fluid or air to leak, the action is always positive and maintenance is no problem.

These jacks are available in eight standard models with capacities ranging from 2 to 100 tons and with standard raises from 6 to 24 inches. Special raises can also be furnished.

To learn more about how Duff-Norton Worm Gear Jacks may be used in your equipment, send for the bulletin which shows engineering drawings of jacks, Duff-Norton Mitre Gear Boxes and typical applications. Ask for AD-66-MD.

DUFF-NORTON COMPANY

Four Gateway Center • Pittsburgh 22, Pa.

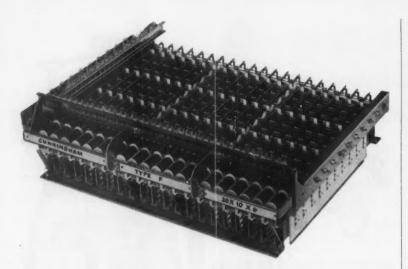
DUFF-NORTON JACKS

Ratchet • Screw Hydraulic • Worm Gear



COFFING HOISTS

Ratchet Lever • Air Hand Chain • Electric



Tolerance Buildup No Bugaboo with Punched Laminated Plastics Parts

The compounding of individual tolerances on several punched holes or cutouts over the length of the piece is not the bugaboo that many designers believe. Careful die work and good working knowledge of the laminate used minimizes tolerance buildup. A good example of what can be done is the insulated pusher fabricated by Taylor for a high-performance crossbar switch manufactured by James Cunningham, Son & Co., Inc., Rochester, N.Y.

These switches are 3-dimensional conductor matrices, with from 30 to 1200 switching contacts, which bring intelligence from as many as 600 sources to one or more readout or signal points. They are basic components in computers, machine tool programming systems, high frequency scanning systems, thermocouple and strain gage monitoring, and similar equipment.

The insulated pusher, only 2.955 in. long and .031 in. thick, and fabricated from Taylor Grade GEC-500 glass epoxy laminate, is a critical part of the crossbar. It must be held flat within $\pm .005$ in., with total over-length buildup not exceeding $\pm .002$ in.

The materials used before to fabricate the pusher proved difficult to hold to the tolerances required. The success of the GEC-500 laminate fabricated by Taylor is evidenced by marked reduction in rejects and a 20% gain in production.

Taylor Fibre's Fabricating Division has the manpower, experience and equipment to produce parts to close tolerances from any of the company's raw materials. Send us your problem—we will recommend the best material for the job and quote on production runs. Write Taylor Fibre Co., Norristown 47, Pa.



Metal-Clad Switchgear

Charts and diagrams in Bulletin GEA-5664F detail the versatility, system protection, safety, compactness, ease of maintenance, and ease of ordering metal-clad switchgear. Book provides features, installation data, dimensions, and ratings for switchgear ranging from 2.4 to 13.8 kv and 75 to 1000 mva. Typical basic equipment arrangements are discussed. General Electric Co., Schenectady 5. N. Y.

Printed-Board Connectors

Pos-E-Kon connectors for flat conductor cable and flexible etched circuitry are discussed in Bulletin P2-39. Various applications are pointed out, as well as special features and dimensional data. 4 pages. Pos-E-Kon Div., Thomas & Betts Co. Inc., Elizabeth, N. J.

Circle 543 on Page 19

Sight-Flow Indicator

Brooksight flow indicator meets the requirements of chemical processing industries since it has no blind threads. Bulletin 820 details various models, gives pressure and temperature ratings, data on materials and specifications. 4 pages. Brooks Instrument Co. Inc., Hatfield, Pa.

Screw-Lock Inserts

New inserts incorporate a grip coil near the center of the insert to prevent loosening. Bulletin 738-C shows how the inserts are used and how they improved certain assemblies in use. All specifications are given for both production and military use, and tools are also listed. 8 pages. Heli-Coil Corp., Danbury, Conn.

Circle 545 on Page 19

Air Motors, Pumps, Compressors

Bound loose-leaf catalog describes rotary-air motors from 1/20 to 7 hp, compressors from 0.6 to 45 cfm, to 30 psignand vacuum pumps from 0.6 to 50 cfm, to 28 in. Hg. Catalog contains specifications, drawings, and performance charts, plus 12-page application ideas section. 42 pages. Write on company letterhead to Gast Mfg. Corp., 23136 Highway M-139, Benton Harbor, Mich.

Time Controls

"Basic Timing Instruction Manual," starts with an elementary explanation of time controls and circuitry and progresses to complex application diagrams. It is intended as a beginning text for rapid understanding of basic time-control principles and applications. Specific subjects covered include: Basic construction of time controls, simplified explanation of switches and circuits; function and operation of elapsed-time indicators, cycle timers, interval timers, time-delay timers, and Acrotimer reset timers. 5 x 7 in., 70 pages. Write on company letterhead to Haydon Div., General Time Corp., Torrington, Conn.

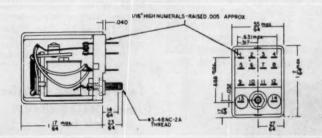


KHP SERIES SHOWN ACTUAL SIZE

ng rare loi

This small, 4-pole relay has the happy faculty of maintaining its original operating tolerances over an exceptionally long life. Example: tests (by customers!) show this relay has variations in electrical characteristics of less than 5% after more than 100 million operations.

But that's far from all. This is a small relay . . . about a one inch cube. This relay is easy to install using the conveniently spaced solder lugs or a socket. Thus you save time and production costs. This relay is versatile . . . its 4PDT contacts will switch loads from dry circuit up to 3 amperes. This relay—well, why not order samples and see for yourself! Order today from your P&B representative or call us at Fulton 5-5251, in Princeton, Indiana.



KHP SERIES SPECIFICATIONS

CONTACTS:

Arrangement: 4 Form C, 2 Form Z.

Material: 1/2" dia. Silver standard. Silver cad-mium oxide and gold alloy available.

Rating: 3 amps @ 30 volts DC or 115 volts AC resistive for 100,000 operations.

COILS:

Resistance: 11,000 ohms max.

Temperature: Operating Ambient: -45°C. to +70°C.

Power: 0.5 watts min operate @ 25°C. 0.9 watts nom. @ 25°C. 2.0 watts max. @ 25°C.

TIMING VALUES:

Nominal Voltage @ 25°C.
Pull-in time
Drop-out time

Max. Values 15 ms 5 ms

INSULATION RESISTANCE: 1500 megohms min.

DIELECTRIC STRENGTH:

500 Volts RMS 60 cycles between contacts.
1000 Volts RMS 60 cycles between other elements.

MECH. LIFE: In excess of 100 million cycles. SOCKET: Solder lug or printed circuit terminals. Available as accessory.

DUST COVER: Standard.

TERMINALS: Solder lug and taper tab.

KHP SERIES RELAY NOW AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



DIVISION OF AMERICAN MACHINE & FOUNDRY IN CANADA: POTTER & BRUMFIELD, DIVISION OF AMF CANADA LIMITED, GUELPH, ONTARIO

New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Recirculating Roller Bearing

has low coefficient of friction

Recirc-L-Way bearing has a coefficient of friction as low as 0.00025-in, under 500-lb load and 0.25 ipm linear motion. With this load and speed, bearing has one-eighth the coefficient of friction of other bearings of this type. Recirculating cage has positive roller guidance between lipped raceways. Cage also maintains uniform spacing of rollers,



eliminating rubbing friction; ends erratic performance, particularly at low speeds, caused by sliding skewing, and binding of the rollers; and pulls unloaded rollers around the bearing raceway. Bearings are designed for high-capacity applications for vertical or horizontal linear reciprocating motion of machine elements or slides of precision machine tools. Bearings are made to order at this time. Kaydon Engineering Corp., Muskegon, Mich.

Circle 546 no Page 19

Dry-Coil Torque Motors

have strokes from 0.005 to 0.015 in.

Dry-coil torque motors are now available in four models for military and industrial applications. Model 121 has a stroke of ± 0.005 in, and an output force of 2.5 lb; Model 122 has a stroke of ± 0.007 in. and an output force of 5.0 lb; Model 123 has a stroke of ± 0.010



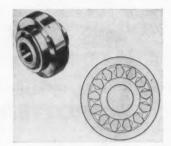
in. and output force of 8.0 lb; and Model 124 has a stroke of ±0.015 in. and output force of 13.0 lb. Units withstand up to 6000 psi working pressure between working fluid and torque motor proper. Air gaps are sealed with a nonmagnetic material to eliminate malfunction due to airborne magnetic particles. American Measurement & Control Inc., 240 Calvary St., Waltham 54, Mass.

Circle 547 on Page 19

Miniature Clutches

for use in missiles, instruments, and small business machines

Miniature, sprag-type clutches, FS-02 and FS-04 general-purpose units, meet high performance requirements in over-running and indexing applications. Model FS-02 provides 4.5 lb-ft torque and is available with 0.250-in, bore. FS-04 has 17 lb-ft torque capacity and is available in bore sizes of 0.375 and 0.500 in. Models are designed for high, continuous over-running speeds to 3450 rpm on model FS-02 and 2400 rpm on the FS-04. They



index at rates to 5000 cpm. Gears, sprockets, pulleys, and similar devices for connecting clutches to driven equipment can be mounted on the OD of the clutch. Formsprag Co., 23601 Hoover Rd., Warren, Mich.

Circle 548 on Page 19

Floating Lock Nuts

for honeycomb or sandwich-type panels

Series 700 lock nut combines a floating-nut element with a structural-type panel fastener. Available for honeycomb or sandwich-type panels, fastener allows for total misalignment of 1/16 in, Series is



available for $\frac{1}{4}$ -in. panels and up, in sizes from No. 8-32 to $\frac{1}{4}$ -28. Body section is furnished in aluminum, carbon steel, or stainless steel. **Delron Co. Inc.**, 5224 Southern Ave., South Gate, Calif.

Circle 549 on Page 19

Two-Part Epoxy Adhesive

resists heavy peel and shear forces

Tygoweld 34 is a two-part, 100 per cent solids epoxy adhesive that produces continuous peel strength over 40 lb per in. width, and initial breakaway strengths over 100 lb per in. width, obtained without

SILCOLOGY Studies in a now these time-test

CAN WORK FOR YOU

Do You Control Motion? Restrain, Release It? Silicone Fluids Are Helping Rewrite the Rules

Need a big-muscled spring to fit a pintsize space? You can now get a fluid spring 1/40 the size of an equivalent coil spring. Need a hydraulic shock absorber with a "flat-topped" energy absorption curve between minus 60 and plus 500 deg. F.? You can now get it. Want the two in one unit? You can get that, too.

The common denominator of such high-performance devices is a series of UNION CARBIDE Silicone Fluids. They range in viscosity from 10 centistokes to 100,000, with pour points as low as minus 85 and flash points above 600 deg. F.

MILLION POUND CAPACITY. This revolutionary, patented 1,000,000-pound Taylor liquid spring utilizing the precisely known compressi-bility of UNION CARBIDE Silicone Oil, is said to be the highest force spring ever produced in a single unit. Only a foot in diameter, it could support three of the largest locomotives. On top of it sits Taylor's smallest liquid spring. Beside it is a locomotive coil spring of almost the big spring's size, but providing only 10 tons of force.

COMPRESSIBILITY PLUS STABILITY

Two of silicone fluids' outstanding properties contribute greatly to their growing usefulness in a variety of hydraulic devices including springs, shock absorbers, torque convertors, dash pots, valve lifters, many more. These are compressibilitythe highest known for polymeric fluidscombined with stability at temperature extremes.

The per cent compressibility of Union CARBIDE L-45 and L-527 Silicone Fluids, compared to conventional mineral oil, is shown in the accompanying chart. The viscosity temperature coefficient V210°F. \ for L-45 with nominal V100°F.

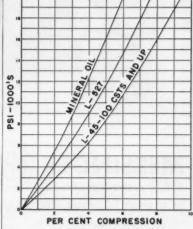
viscosity of 100 ctsk. is 0.63.

NAME YOUR OWN SPRING RATE

Taylor Devices, Inc., of North Tonawanda, N. Y., is one of the companies adapting these highly useful qualities to hydraulic equipment. In tension and compression devices, for example, using a stepped tubular piston design and L-45 fluid, they achieve virtually any desired spring rate and force, within a compact, structurally stable mechanism.

Again, in spring-shock absorbers where high mechanical energy is converted to heat energy, Taylor Devices find UNION CARBIDE Silicone Fluids greatly extend the useful work range of the units.

Among the jobs such devices are per-



Compressibility of UNION CARBIDE Silicone Fluids vs. Mineral Oil

forming are: Scram-rod cushions in nuclear reactors, taking impact loads on aircraft arresting hooks, cushioning aircraft radar antennas. In addition, they arrest circuit breaker mechanisms at interruption, stop rolls of paper on paper machines, and control feed rate of electrodes on electric furnaces.

R AND D TO HELP YOU

If you design hydraulic equipment for tough duty, your UNION CARBIDE Silicones Man has a wealth of technical know-how on the ways Silicone Fluids can help you obtain outstanding performance. Behind him are the vast experience and research of Union Carbide Corporation in virtually every field of industry.

We invite you to send at once for our comprehensive "Design File" on UNION CARBIDE Silicone Fluids for Mechanical Applications. It gives you in one handy package just about all you need to know about silicone fluids for your design requirements. Mail the coupon today.



SILICONES

Union Carbine is a registered trade mark of Union Carbide Corporation.

Silicones Division Union Carbide Dept. FL-4106, Long Island Cit	Corporation 30-20 Thoms	on Avenue
In Canada: Unio	on Carbide Ca	
Please send me Union Carbide ical Application	Silicone Fluid	
NAME		
TITLE		
COMPANY		
Address		
Сіту	ZONE	STATE

THERE'S VIRTUALLY NO LIMIT... to the

Shaft Diameters and Over-all Dimensions of



MESSINGER PILLOW BLOCKS

Some you can hold in the palm of your hand; others require heavy-duty cranes to lift them in position; but regardless of size, they are completely engineered by Messinger craftsmen to assure faultless performance for many years.

DIAMETERS OF 25" AND LARGER

DIAMETERS OF 25" AND LARGER for installations like the "sheaves" of the Houghton-Hancock Bridge between Houghton and Hancock, Michigan. Eight Messinger Pillow Blocks, four on each side, contribute to the smooth operation of this vertical lift bridge. Each Pillow Block measures 72.00" x 56.00" x 39.63", 25.50" diameter shaft.

Features of all Messinger Pillow Blocks include exceptional compactness; efficient oil seals; automatic flood oiling; and the use of self-aligning roller bearings to compensate for misalignment of support.

Two Typical SMALLER DIAMETER Units ...



Left—a Pillow Block designed for 12.00" diameter shaft. This illustrates one arrangement for automatic flood oiling from built-in oil reservoir.



Left—a Messinger Pillow Block, with self-aligning radial roller bearing, for 5.50" diameter shaft.

* * * *

Note the extreme compactness in over-all height. Both of the above units can be designed for shafts of any diameter.



Bearings may be radial or combination radial and thrust, to handle any type

of loading.
If available space is a problem, consultation with a Messinger engineer-representative may be helpful. ROLLER AND BALL BEARINGS



NESSINGER (((MX))) BEARINGS, Inc. FEATHERWEIGHT TO HEAVYWEIGHT

D STREET ABOVE ERIE AVE. . PHILADELPHIA 24, PA.

"Smoothing Industry's Pathway for Nearly Half a Century"

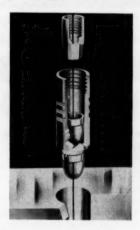
sacrifice to tensile shear properties in the 3000 psi range. The se strengths were obtained on aluminum-to-aluminum bonds. Curing can be done at ambient temperatures or accelerated by the use of elevated temperatures. Material was developed for use on structural-panel applications. Adhesives Div., United States Stoneware Co., Chamberlain Laboratories, Research & Development Center, P. O. Box 624, Stow, Ohio.

Circle 550 on Page 19

Fluid-Flow Regulator

incorporates 100-mesh screens

Lee Jet consists of a calibrated orifice, two matched filters of 100-mesh screen, and locking and sealing device. Jet is slipped into reamed hole



until it seats at the shoulder; pin is pressed into Jet to lock and seal it. Flow can be in either direction. Units are removed by means of an extraction tool; jet and pin are reusable. Length of unit is 0.550 in., diameter is 0.1875 in. Lee Co., Westbrook, Conn.

Circle 551 on Page 19

Shaft Key

eliminates backlash and relative rational movement

Double Taper Lock Key utilizes a key having lateral bearing surfaces of opposite longitudinal slope. Wedging action is obtained between key and shaft and key and gear, eliminating backlash or relative rotational movement between the shaft and gear. Same bearing sur-



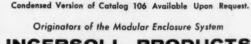
EMCOR STANDARD CABINETS

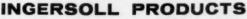






- Cut enclosure design time. Select your packaging needs from a complete line of standard and heavy duty EMCOR Cabinets.
- EMCOR MODULAR ENCLOSURE SYSTEM Cabinetry provides for thousands of control center combinations.
- Choose from hundreds of EMCOR Cabinet widths, depths and heights offering an exclusive combination of engineered features.
- Engineered simplicity of basic frames and components affords quickest and easiest erection of control center assembly.
- EMCOR Cabinetry Engineers backed by the research and development "know-how" of the Roy C. Ingersoll Research Center set the pace for the packaging needs of electronics, instrumentation and electro-mechanical engineers from coast to coast.
- Rugged frame construction surpasses all standard requirements for increased load carrying capacities.
- Compatible cabinet design assures simplified and economical expansion at any time.
- EMCOR Cabinet manufacturing meets rigid quality-controlled craftsmanship standards.
- Nationwide organization of EMCOR Sales-Engineering Representatives assist in planning stages and assure customer satisfaction beyond the sale.





Division of Borg-Warner Corporation 1000 W. 120th ST. • DEPT.1226 • CHICAGO 43, ILLINOIS





Iron and steel particles that wear off moving parts and circulate in the lubricant are a primary cause of wear to bearings, bushings, gears, cams, etc.

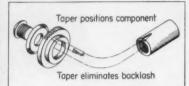
PLUGS

The powerful magnet in the Lisle Magnetic Plug pulls these particles out of the lubricant - assuring longer, quieter, trouble-free, operation of your product.

Lisle Magnetic Plugs can be used in place of any ordinary drain or fill plug.

FREE Samples for Testing in Your Product! LISLE

CORPORATION



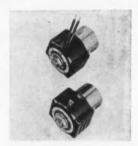
faces align the gear axially on the shaft, eliminating the necessity of providing a shoulder or other retaining means. Lengths of the units range from 0.470 to 2.450 in. Sure-Lok Co., 7701 Melita Ave., North Hollywood, Calif.

Circle 552 on Page 19

Solenoid Valve

incorporates completely encapsulated magnetic circuit

New moistureproof solenoid valve includes a magnetic circuit completely encapsulated in epoxy. Series 10 valves are small, compact, and can be supplied with rectifier diodes molded into the unitized magnetic circuit. Diodes, which allow the valve to operate as a dc unit from an ac power source, do not increase valve size. Valves can be used with or without an outer housing, can be



rotated 360 deg, and are reversible. Peter Paul Electronics Inc., 251 Whiting St., New Britain, Conn. Circle 553 on Page 19

Beliows Couplings

in subminiature to medium size

Hi-Flex subminiature and mediumsize couplings can be used for highly sensitive applications. Miniature sizes are particularly applicable to servomechanisms and computers. Where backlash and cyclic angular variations between shafts cannot be tolerated, couplings can stretch or compress enough to drive a screw

NOW! DORMEYER PRESENTS "AMERICA'S FINEST SOLENOID LINE"



here it is-completely newcompletely redesigned-the

DORMEYER SUPER-T-LINE

Check these new and improved features

- · Heavier, Sturdier Mounting Brackets
- Extra Heavy, Well Supported Plunger
- High Seating Pull without excessive AC Hum
- High Dielectric Bakelite Bobbin
- Stainless Steel, Non-Rusting, Anti-Residual Spring
- Larger Contact Area between Co-acting Members for Longer Life
- Stronger, Heavy Gauge, Pull-Bar
- Moisture Resistant Coil
- Moisture Proofed or Epoxy Resin Encapsulated Coils available for High Humidity Conditions
- Design provides for Maximum Work without Power Drop-Off

More rugged, with greater designed-in and built-in dependability, the new Super-T deserves to be called "America's Finest Solenoid Line". Write for Catalog today!

DORMEYER INDUSTRIES

Also Builders of Special Coils and Transformers

3434 Milwaukee Avenue • Chicago 41, Illinois



NO LARGER GENERATOR SHAFT EVER FORGED ANYWHERE

Shipped recently to the General Electric Company's Large Steam Turbine Generator Department at Schenectady, N. Y., this shaft weighs 233,865 lb and measures 38 ft, $9\frac{1}{2}$ in. long. The shaft will be machined and assembled by G. E. for a turbinegenerator unit to serve Tennessee Valley Authority's Paradise Steam Generating Station at Paradise, Ky.

The 116-ton shaft was forged from a 120-inch diameter ingot that required the combined output of five electric-furnace heats, or roughly 260 tons of vacuum-poured, nickelmoly-vanadium steel. It was the largest ingot ever cast in a vacuum by Bethlehem. No larger generator shaft has ever been forged.

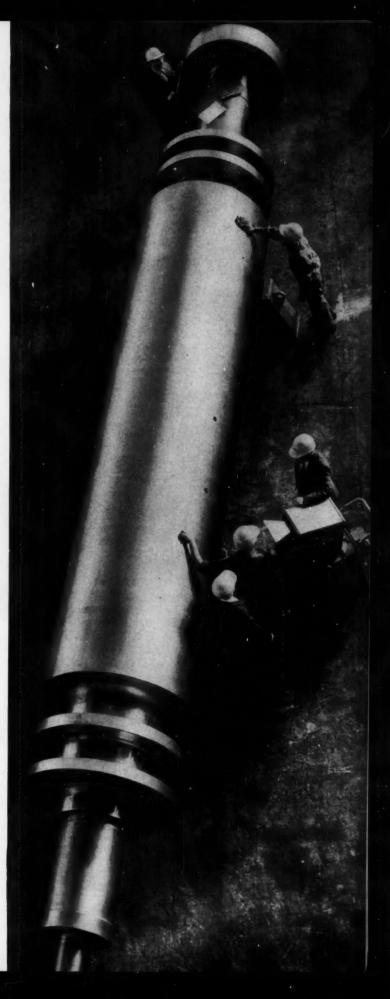
The generator shaft was fully heat treated and sonic tested. It has a maximum body diameter of 59 1/4 in.; minimum diameter of the forging is 11 1/4 in. The generator will operate at 1800 rpm, providing a maximum electrical output of 391,111 kva.

BETHLEHEM STEEL COMPANY BETHLEHEM, PA.

Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL









SILENGE

Lead at work!

Chalk up one for lead when it comes to a genuine genius for isolating sound. That's because, thickness for thickness, lead is 13 times more effective at blocking sound transmission than the next best commonly used construction material... up to 24 times more effective than some others.

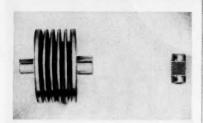
And lead's characteristic density and limpness also make it stack up better pound for pound. Lead gets an "A" for conduct and cooperation, too. It's tackable, paintable, fireproof and malleable—folding or bending to "dress" even over complicated surfaces. It is applicable to buildings, machinery, transportation equipment and almost every area where sound control is a problem.

LOOK AHEAD WITH CEAD



Technical data and charts prepared by the acoustical consulting firm of Bolt, Beranek and Newman are all contained in this brochure.

For your copy of the new 12-page report, Improved Sound Barriers Employing Lead, write to Lead Industries Association, 292 Madison Ave., New York 17, N. Y.



while rotating with negligible side thrust on bearings. Instrument Div., Sterling Precision Corp., 17 Matinecock Ave., Port Washington, L. I., N. Y.

Circle 554 on Page 19

Aluminum-Vinyl Laminate

in flat or coiled sheet has many applications

Vynalate laminate of aluminum sheet and vinyl-plastic film is furnished in a large range of coatings, embossed and printed with up to five colors. It is offered in 39 color combinations, or with any commercially available vinyl-plastic film, or with custom designs. Material is produced in wide coils and in linear-type patterns. Available as flat or coiled sheet, laminate lends itself to high-speed, volume production; it can be worked by any operation feasible with aluminum sheet. Vynalate is produced in widths to 48 in., with metal thickness from 0.015 to 0.051 in., in a variety of alloys and tempers. PVC film cladding on the sheet is 0.008 through 0.014 in. thick, depending on finish requirements. Aluminum Co. of America, 791 Alcoa Bldg., Pittsburgh 19, Pa. Circle 555 on Page 19

Synchronous Induction Motor

has pull-out torque of 8 oz-in, minimum

New synchronous induction motor is a single-phase, 60-cycle, 115-v, capacitor start-run type, which em-



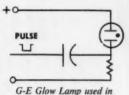
4 ways to use

General Electric Glow Lamps as Circuit Components



1. As a MEMORY DEVICE, because of the differential between starting and operating voltages. Both the General Electric NE-96 and NE-97 are well suited for switching circuits and counters where they can function as transfer elements and as indicators of state or sequence.

2. As a VOLTAGE INDICATOR.

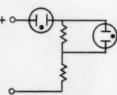


Memory Circuit



because of their critical starting voltage.

The G-E NE-76 and the NE-81 are stabilized and selected for close tolerance on starting voltage. Both find use in gating circuits, logic matrices, switching circuits or as an indicator of input or output levels.

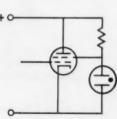


G-E Glow Lamps as Multiple Voltage Indicators



because of their constant operating voltage range. The General Electric NE-68 and its "first cousin", the G-E NE-80 (closer tolerance), function effectively wherever voltage regulation is required. (Glow Lamps for higher current applications are also available.)

3. As a VOLTAGE REGULATOR,

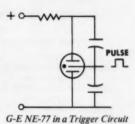


G-E Glow Lamp used as a Voltage Regulator



4. As a TRIGGERED SWITCH.

A low current signal applied to the trigger (third electrode) starts this lamp, permitting conductance of peak current surges up to 100 m.a. in the power circuit. It can be used in counting circuits or as a control device with photocells, thermostats or moisture sensors in trigger circuit.



For more information, write for: Specification Sheet #3-092 "G-E Glow Lamps for Circuit Component Use". General Electric Co., Miniature Lamp Dept. M-126, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product



5,000 psi MERCOID PRESSURE CONTROLS



RANGE 500 to 5,000 psi.

External Adjustment Sealed mercury contact Visible calibrated dial Visible on-off circuit Repetitive trip point

TYPES AVAILABLE

DXA-21
minimum differential 450 psi.
DXA-521
minimum differential 200 psi.
DXS-221
minimum differential 150 psi.

Available in three case styles; General Purpose Weather-Proof Explosion-Proof

WRITE FOR BULLETIN 0-21

THE MERCOID CORPORATION
4205 BELMONT AVENUE
CHICAGO 41, ILL.

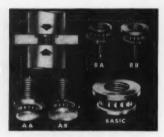
ploys 3 mf capacitors. Motor, with 1.88 in. diam and 2.25-in, length, exhibits pull-out torque of 8 oz-in. minimum. Task Corp., 1009 E. Vermont Ave., Anaheim, Calif.

Circle 556 on Page 19

Flush-Mounted Fasteners

of alloy steel meet MIL-N-25027 requirements

Flush-mounted, pressure-displacement fasteners of alloy steel are for installation into ductile material using standard punch-press procedures. Fastener is installed by pressing the large flange into the ductile sheet; displaced material forms into the knurled undercut. Types BA and BB (self-locking append-



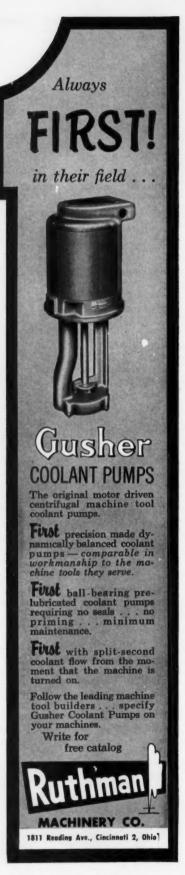
ages) and basic flush-mounted fasteners are for 550 F temperatures and are available from stock. Types AA and AB studs are for 550 F use and are available two weeks from receipt of order. BA and BB types meet requirements of MIL-N-25027. Fasteners are available for sheet thicknesses of 0.040 through 0.180 in. and in thread sizes from No. 2-56 through \(^1/4\)-28. Material is high-carbon steel, cadmium plated per QQ-P-416, Type II, Class 3. Stake Fastener Co., 1710 Potrero St., South El Monte, Calif.

Circle 557 on Page 19

Check Valve

has operating pressure of 3000 psi and up

Deccto check valve has leakproof check action and extremely low pressure drop. Operating pressure is 3000 psi and up, with 10 psi drop in pressure at rated flow. Use of a hydraulic deceleration device eliminates surge shock. One-piece body cannot come apart when pipes or fittings are removed. Operating temperatures range from -250 to



FOUR NEW UNIVERSAL ELECTRIC FRACTIONAL H.P. MOTORS

featuring Free-Aligning bearings

-either sleeve or ball

UNIVERSAL ELECTRIC

Type 23 4 pole sleeve bearing
Type 63 6 pole sleeve bearing

Type 523 4 pole ball bearing

Type 563 6 pole ball bearing

Primarily because of their new bearing assemblies (free aligning sleeve or free aligning ball), these four new UNIVERSAL motors operate at a reduced noise level, start easier and assure an extremely long operating life. They insure maximum performance and efficiency for kitchen ventilators, unit heaters, evaporative coolers, condenser fans, refrigerated cabinets, etc. These UNIVERSAL ELECTRIC motors also offer the perfect flat speed torque curve necessary for critical air moving or recorder applications.

UNIVERSAL Ball Bearing Assembly is resiliently suspended in a neoprene collar confined in small metal clips that allow free movement along bearing support surface. With axis of support at its center, bearing can adjust to any shaft misalignment. Advantages: reduced noise level, easier starting, no snap rings or shoulders or undercuts for stronger motor shaft, no pre-loaded bearings due to misalignment for free-running motor, longer motor life.



UNIVERSAL Sleeve type bearing eliminates fhp motor bearing problems due to misalignment. Like ball bearing assembly, sleeve bearing is inherently in balance; can adjust to any shaft misalignment 100% of the time under any load conditions.

SPECIFICATIONS

Shaft Diameter-% or 1/2 inches

Mountings—4 point on $2^2\%2''$ or 3%2'' (either end of motor)

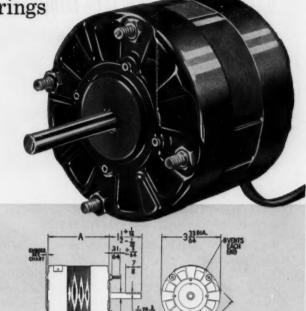
Either Fan or Mechanical Duty; Internal Fan

All Angle Operation

Cases—Drawn steel, formed and embossed for maximum rigidity, compact, rugged design

Rotor—Diecast and machined to precision tolerances

Dual and Three Speed Windings 115 or 230 volt, 50 or 60 cycle Totally Enclosed Types Available Complies with CSA and U/L Requirements



4 POLE SPECIFICATIONS

Model			Watts	Amps.		
Sleeve	Ball	H.P.	Speed	Input	Input	"A"
23E6	523E6	1/50	1550	65	0.8	215%
27E8	523E8	1/35	1550	80	1.0	23%
23E10	523E10	1/25	1550	105	1.4	231/2
23E12	523E12	1/15	1550	165	2.2	3 1/2
23E14	523E14	1/12	1550	210	3.0	315/2

6 POLE SPECIFICATIONS

M	lebe			Watts	Amps.	
Sleeve	Ball	H.P.	Speed	Input	Input	"A"
63E6	563E6	1/60	1000	75	1.0	215/2
63E8	563E8	1/40	1000	95	1.3	233/4
63E10	563E10	1/30	1000	125	1.7	231/2
63E12	563E12	1/20	1000	175	2.3	3 %
63E14	563E14	1/15	1000	230	3.1	315/2

Write for complete specifications on your requirements.

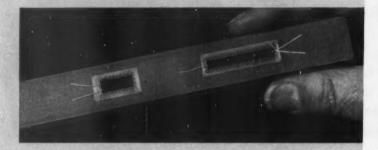
UNIVERSAL ELECTRIC COMPANY

PRECISION ELECTRIC MOTORS

EXECUTIVE AND GENERAL SALES OFFICES: OWOSSO, MICHIGAN, DEPT. 10



BLH ADVANCES THE STRAIN GAGE ART WITH NEW WELDABLE, PRE-STABILIZED GAGES THAT INSTALL IN MINUTES



For the first time, strain gages that are both easily weldable and electrically stable from cryogenic through 750°F temperatures.

New BLH Weldable Strain Gages incorporate special SR-4* foil gages bonded to stainless steel shim stock .005 in. thick which can be matched to the coefficient of the test material. This new development enables gages to be closer to the test surface, improves conformity with the surface, and eliminates local buckling.

No curing needed after installation, because the gages are fully stabilized by heat treating. They offer high linearity of strain response in either tension or compression and operate in a strain range of $\pm 0.5\%$.

Two types available—a phenolic-bonded Constantan foil for temperatures to 500°F, and a ceramic-bonded Nichrome V foil for temperatures to 750°F and higher. Temperature compensation is available to ±1 ppm/°F for units utilizing Constantan foil.

Wide range of applications is seen for testing nuclear reactor power loops, liquefied gas pressure vessels and systems, rocket and missile components and engines, and wind tunnel and shock chamber testing of aircraft parts.

Available locally through 16 BLH sales engineering representatives in the U.S. and Canada. For detailed information or assistance, contact the one nearest you—or us here in Waltham.

BALDWIN • LIMA • HAMILTON
Electronics & Instrumentation Division
Waltham 54, Mass.



SR-4® Strain Gages • Transducers • Temperature Sensors • Systems

3

+500 F, since there are no dissimilar materials to cause differential expansion and contraction. Standard units are available in sizes from $\frac{3}{8}$ to 1 in. Bruning Co., 601 S. Ninth St., Lincoln, Neb.

Circle 558 on Page 19

Sleeve Bearings

incorporate rotatable cartridge to provide longer life

Self-aligning, self-lubricating Flex-Block sleeve bearings in flanged and pillow-block types operate in temperatures to 1000 F, in corrosive and contaminating conditions, in inaccessible locations where lubrication and maintenance are problems, where noise control is important, at slow speeds, and under water. Sleeve-bearing cartridge is held in position in the housing by means of a set screw which, when backed



off, allows the cartridge to be rotated 180 deg without removing the bearing from the shaft. Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.

Circle 559 on Page 19

Printed-Circuit Connectors

for microminiature electronic applications

Series 600-2 continental printed-circuit connectors are small, precision-designed card receptacles for microelectronic applications. Forty contacts with 0.050-in. center-to-center spacing are mounted in I 11/16-in.

PRODUCT-DESIGN BRIEFS FROM DUREZ

- Plastic bearing material
- Making epoxies retard fire
- Phenolic for motor housings



MICRO-PRECISION DIVISION.

Outwears metal bearings

Loads as high as 50,000 psi don't bother this plastic bearing.

In severe high-load, low-speed tests, it came through 60 million cycles without failure—while ordinary bearings gave up at 50,000 cycles.

What helps make it so rugged? One fact is the material used on the outside to encase the bearing material. The bearing material may be considered an insert which is molded in place in one operation. The support material is Durez 16771, a glass-filled phenolic molding compound.

Besides being strong and tough, Durez 16771 withstands oil, grease, and acid; can't pit, rust, or corrode.

What can you do with an idea-plastic like this? Automotive designers are putting it to work now in oil-pump gears, automatic transmission parts. Check into the places where a tough, high-impact plastic could do a better job than the material you're using. Then ask your molder for more details on Durez 16771—or check the coupon for Bulletin D203, which describes the material and its capabilities.

The hardener does it

Could you be looking for an epoxy that retards fire?



Here are two epoxy laminates we made up in the laboratory. Both were exposed to equal flames for 30 seconds. When the flames were removed, one laminate blazed merrily on. The other snuffed out instantly, with slight local charring.

The only difference in composition was in the hardener or curing agent used: at the left, a conventional one; at the right, our HET® Anhydride.

Besides conferring flame retardance, HET Anhydride gives a liquid epoxy resin a high heat-distortion point and superior flexurals at 350°F. It won't stain hands or cause dermatitis. And it costs less than most hardeners.

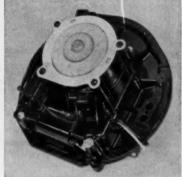
We don't make epoxies, but we'll be glad to send you data on HET Anhydride. Just check the coupon for it.

Housing for life

Here is part of an appliance not built for planned obsolescence.

The new Hoover convertible vacuum cleaner, say its makers, is designed for virtually a lifetime of service. Its engineering represents over 50 years of leadership in a highly competitive field.

It's significant, then, that to enclose the cleaner's two-speed ¼-hp motor, Hoover designers settled on a housing of molded Durez phenolic.



THE HOOVER COMPANY

You needn't look far to find good sound reasons for using phenolic to mount or protect a motor. Phenolic gives lifetime stamina at low cost. It's rugged, non-warping—yet weighs less than other housing materials. On a complex part, it can save you much machining.

Your custom molder can tell you more. Or use the coupon to request fact-crammed Bulletin D400 on Durez molding materials, their properties, and uses.

or more information on Dure	products mentioned	above, check here:
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- ☐ High-impact molding compound Durez 16771 (Bulletin D203)
- ☐ Epoxy hardener, HET Anhydride (Bulletins 19 and 43)
- ☐ Durez molding materials (descriptive Bulletin D400)

Check, clip and mail to us with your name, title and company address. (When requesting samples, please use business letterhead)

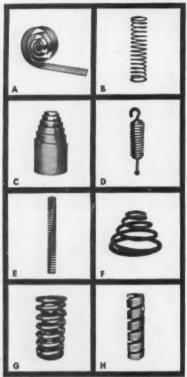
DUREZ PLASTICS DIVISION

5 0 6 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION



Can you identify these springs?



A. flat B. helical C. volute D. extension E. helical F. cone G. helical, triple-coil H. rectangular section

Over One Million ALCO SPRING DESIGNS

ALCO's complete line of "performancerated" springs ranges from small springs for light work to heavy-duty triple-coil springs for heavy, sustained work.

In over 80 years, ALCO engineers have produced more than one million spring designs to serve almost every conceivable application.

For your next spring job, contact your nearest ALCO sales office. To obtain brochure, ALCO Springs for Industry, write to ALCO Products, Inc., Dept. 160, Schenectady, N. Y.



ALCO PRODUCTS, INC.

NEW YORK

SALES OFFICES IN PRINCIPAL CITIES

NEW PARTS AND MATERIALS

long molding. Contacts provide coil spring-action grip over entire contact area of printed-circuit boards. Contacts accept a 1/32-in. printed-circuit board or tape cable. Recommended test voltage at sea level is 900 rms, current rating 1 amp. Illustrated are wire terminals in



straight position and with rightangle bend. Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 560 on Page 19

Split Locking Collar

of self-lubricating wood

Pobco collar can be applied to any existing shafting supported by plain, journal-type bearings. Split feature allows installation in limited-access areas. Made of self-lubricating wood, collar also serves as a thrust surface which eliminates metal-to-



metal contact, insuring quieter operation. Paramount Oilless Bearing Co. Inc., 99 Hope Ave., Worcester, Mass.

Circle 561 on Page 19

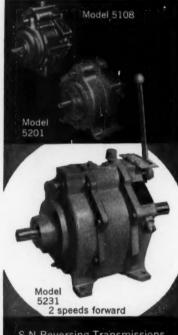
Industrial Fastener

has new, tamperproof head design

Torqtite fastener is basically a new head design that can be adapted to screws, Springtites, or Sems. Unit head has three equally spaced driving slots on its outer periphery, making it necessary to use a special

S-N REVERSING TRANSMISSIONS

5 models 8 and 28 h.p. with power packed versatility



S-N Reversing Transmissions are performance proven, space-saving single units which reverse under full load. Adaptable to the design or redesign of a wide variety of industrial equipment. For technical data write The Snow-Nabstedt Gear Corp., Hamden, Conn.

SPECIFICATIONS

Model No.		5231	5201	5108
Reduction Forward		1.97:1 3.34:1	3.16:1	3.75:1
Ratio Reverse		3.37:1	3.16:1	3.75:1
Power Up To		28 HP	28 HP	8 HP
Max. Input Torque in. Ibs.		1000	1000	320
Max. Input Speed	RPM	2400	2400	2400
Dimensions	Long Wide High	15 ¹¹ /16" 14" 14%"	11½″ 13½″ 14¼″	9½6" 10" 10%"



SNOW-NABSTEDT

Industrial Division
Transmission Engineers
For Over Half a Century



tool for driving and for loosening, thus making unit tamperproof. When the unit is driven, forces are on the outer periphery instead of in the center, eliminating head distortion through worn driver bits. Reliance Div., Eaton Mfg. Co., Massillon, Ohio.

Circle 562 on Page 19

Rotary Face Seals

for temperatures from -65 to +520 F

Bellows-type rotary face seals are for use where minimum envelope length is required. Design features a short, one-piece bellows welded flush to the flange-type mount. Graphite-carbon seal recessed in the housing accommodates the shaftwear ring within the envelope length of the rotary face-seal assembly. Constructed of stainless steel, assembly is subjected to 2200 psi surge pressures and a normal



operating pressure of 500 psi. Actual burst pressure is in excess of 5000 psi. Temperature range is -65 to +520 F. Hydrodyne Corp., 7350 Coldwater Canyon Ave., North Hollywood, Calif.

Circle 563 on Page 19

Idler Pulleys

have full-complement, double-row ball bearing

Idler-pulley units are designed spe-



Rugged protection with rigid acetate plastic protectors

Try this sometime. Put an S. S. White Quality Line rigid acetate cap (free samples available) on a threaded part and whack the daylights out of it. You'll be surprised when you see how the threaded part comes through undamaged!

Here is the ultimate in protection against impact for your quality products. Rugged, *positive* protection against damage, dirt, fluids...during processing, storage, shipping.

Investigate, also, our **Economy Line** of elastic vinyl protectors; low cost...easy on, easy off, yet a stayput fit...absolutely non-shredding.

Remember for only a few pennies you can protect vital equipment and your customer's good will!

WRITE FOR BULLETIN

P-5708 and Free Samples



PLASTICS



Dept. 4P, 10 East 40th Street, New York 16, N. Y.



RESULT: CLEANER, MORE UNIFORM, LONGER-LASTING LUBRICATION ON LOCK PARTS

Cam retainers and disc tumblers used in American Hardware Corporation's padlocks are 1/2 by 1/4 inch brass stampings. Because of their small size, this New Britain, Conn. manufacturer has found dipping to be the most efficient method of lubricating them. Acheson's 'dag' 154 proved to be ideal for this operation. Its alcohol carrier quickly evaporates, leaving a permanent film of graphite on the parts. This microscopically thin film is deposited uniformly, adheres tenaciously, and will not rub off during lock assembly. Since it does not attract dust and discourages oxidation and corrosion of the brass parts, 'dag' 154 provides a longer, smoother operating life for the locks.

For more information on the advantages of Acheson dry-film lubricants in product design, send for your copy of Bulletin No. 435. Write to Dept. MD61.

ACHESON - First name in solid lubricants for fifty-three years.



PORT HURON, MICHIGAN

A division of Acheson Industries. Inc.

Sales offices in principal cities.

Also Acheson Industries (Europe) Ltd. and affiliates, London, England

NEW PARTS AND MATERIALS

cifically for use as belt tighteners, clutches, belt guides, idlers, and for similar applications. Full-complement, double-row ball bearing with hardened, deep-groove races gives the units maximum load-carrying capacity with high lateral stability. Units consist of symmetrical sheave halves spot-welded together around the bearing. Sheaves are made in a variety of types, adapting the units to applications requiring flat or V-belts. Bearings are prelubricated with heavy-duty grease and are



completely sealed to keep dirt out and retain lubricant. Extended inner race on one side gives mounting clearance and eliminates spacers. New Hampshire Industries Inc., Hanover, N. H.

Circle 564 on Page 19

Miniature Relay Socket

has rear-entry, snap-in contacts

Microminiature relay socket meets applicable requirements of MIL-C-26636. It features rear-entry, snap-in contacts. Measuring 1.34 x 0.35 x 0.36 in., socket is adaptable to both industrial and military applications where packaging space is limited. It is available in 8 and 10-contact configurations, five mounting styles, and crimp-pot accommodations for 20, 22, and 24 AWG wire. Voltage



INDUSTRIAL RETAINING RING PRICES REDUCED UP TO 51%



Series 1000, Series 3000 and Series 3100 Industrial Retaining Ring prices—in quantities up to 100,000—have been greatly reduced.

Thanks to modern, efficient production methods you can now get these Industrial Retaining Rings—either prestacked or bulk packed—at new, low prices . . . and pay less for pre-stacked rings than you have been paying for bulk packed. Reductions apply to standard materials and finishes.

Use this coupon to send for your new, revised IRR Price List.

INDUSTRIAL RETAINING RING COMPANY

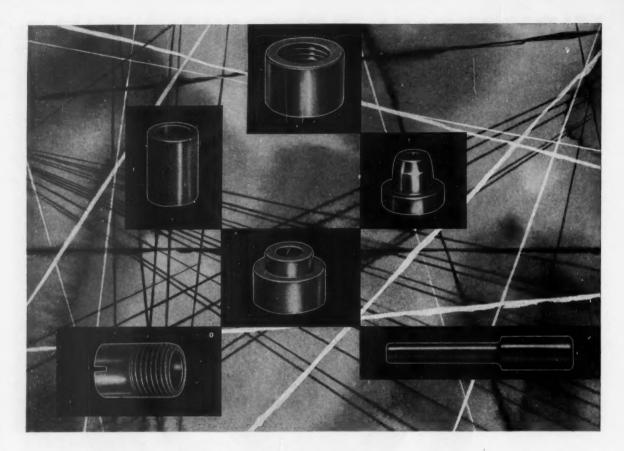
	to have your representative call.
Name	Title
Company	
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Originators of modern retaining ring dispensing

INDUSTRIAL RETAINING RING COMPANY

57 Cordier Street, Irvington 11, New Jersey



Laminated INSUROK® Opens New Design Horizons

FOR COMPONENTS MADE FROM SHEETS, RODS, TUBES AND FABRICATED PARTS

Characteristics of Richardson Laminated INSUROK® of major importance to material and design engineers include: lightweight (half the weight of aluminum), remarkable strength to weight ratio, durability, resistance against corrosion and chemical action, high insulating and heat-resisting qualities, and excellent machinability. Usually, no additional or protective finish is needed. Many grades are specially formulated to produce a specific combination of properties for specific applications.

This combination, and wide range, of properties allows INSUROK® to outperform and outlast metals and other materials in countless applications—mechanical, electrical or chemical.

Our rigid quality control methods and follow-through . . . as the one source for manufacturing the laminated material to fabricating the finished part is your best guarantee of uniform, trouble-free parts. To assure precision tolerances, we maintain the most modern and experienced tool and die shop. Our Melrose Park, Illinois, and New Brunswick, New Jersey, plants provide you with complete fabricating service.

Whenever your product design demands a combination of desirable properties . . . investigate INSUROK®. It is available in rods, tubes, sheets or fabricated parts (including screw machine parts). Contact your nearest Richardson Branch Office for further information. It's likely we can help you solve some of your tough design problems.

Write Dept. 10 for free technical data

THE RICHARDSON COMPANY

Sales Offices In Principal Cities

2795 LAKE STREET, MELROSE PARK, ILLINOIS

Laminated Fabricated and Molded Plastics breakdown at sea level is 3500 v dc, and contact rating is 5 amp. Viking Industries Inc., 21343 Roscoe Blvd., Canoga Park, Calif.

Circle 565 on Page 19

Shaft Extensions

in $\frac{1}{8}$, 3/16, or $\frac{1}{4}$ -in. shaft sizes



Precision shaft extensions, designed for use with like-size shafts, also can be used as adapters to standardize shafts of unlike diameters. Machined from Type 303 stainless steel, with clear passivated finish, in 1/8, 3/16, or 1/4-in. shaft sizes, extensions are furnished with samesize male and female ends, or in any combination of these sizes. Over-all length of extension is 15/8 in., providing for 1 in. of usable shaft surface. All diameters are concentric to 0.0005-in. PIC Design Corp., 477 Atlantic Ave., East Rockaway, L. I., N. Y.

Circle 566 on Page 19

Flow Regulators

have free-flow rates up to 20 gpm

Standard flow regulators regulate flow in one direction with free flow in the other. Units have $\frac{3}{8}$ or $\frac{3}{4}$ in. pipe-thread porting, and SAE straight threads also are available. Nominal free-flow rates range up to 20 gpm, and maximum controlled-flow rate for both sizes is 10 gpm. Units are rated at a pressure of 3000 psi. Two-piece adjust-



Whatever your driven machine, you save it from RUIN

every time this clutch cycles . . .





- Safely limits torque
- Protects against overload-jams
 downtime
- Resumes drive automatically after overload
- # Eliminates shear pins and lost time
- Adjustable-while-running feature available

Walue is related to function—not to cost."
Hilliard Slip Clutches give you continuous, posi-

tive, and reliable protection of drives on packaging machines . . . case loaders . . . conveyors . . . dishwashing machines . . . printing presses . . . circuit breakers . . . and many others.

They also maintain steady torque while permitting speed variation on fabric drying drums, steel strip slitters and similar equipment.

Adjustable-while-running types maintain constant tension on rewind stands for paper coaters, textile machines, rope, steel and wire mills and for drive systems requiring overload protection but which must be disconnected at times.

Write for Bulletin 300 for complete details.

Remember, HILLIARD is your Industrial Clutch specialist . . . for more than 55 years . . . and the line includes Over-Running Clutches, Intermittent Drive Units, Single Revolution Clutches, Hilliard-Twiflex Centrifugal Coupling.



CASE LOADERS



CONVEYORS



MACHINES



PRESSES

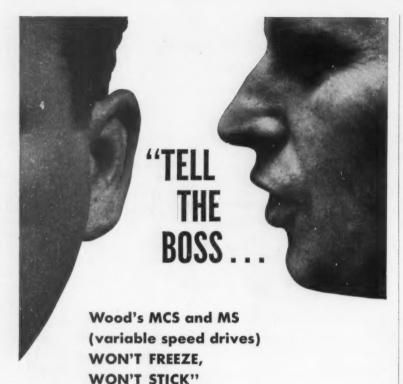
Manufacturing Clutches for over 50 years

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ELMIRA, N. Y.

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And, remind him that Wood's MCS and MS motion control drives solve production and maintenance problems no other mechanical variable speed drives can handle. They won't freeze or stick because there are no keys to obstruct lubrication of bearing surfaces. Revolutionary resilient cam followers or pads, located outside the bearing surfaces, permit continuous rotational pumping action, assure even distribution of oil. And, you check lubrication only three or four times a year. Also, Wood's MCS drives hold constant driven speeds under varying torque loads.



Wood's motion control, variable speed drives are available in capacities from fractional to 25 hp. If you and the boss want more information about these remarkable drives, write for BULLETIN 25103.



T. B. WOOD'S SONS COMPANY - CHAMBERSBURG, PENNSYLVANIA

MCS/2361

ATLANTA · CAMBRIDGE · CHICAGO · CLEVELAND · DALLAS

ing-screw construction allows adjustment under pressure without leakage. Vickers Inc., Div., Sperry Rand Corp., Detroit 32, Mich.

Circle 567 on Page 19

Automatic Clutch

for single-cylinder engines developing 3½ to 6 hp



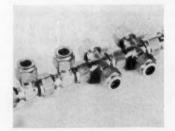
Model 18C6B26 automatic clutch is easily attached to the power source with a key wrench. It is for use in single-cylinder engines developing 3½ to 6 hp. When extra power is needed for starts or steep grades, clutch provides it automatically. Clutch contains only four parts. Applications include garden tractors, scooters, and powered lawnmowers. V-Plex Clutch Corp., 612-616 S. Elm St., Muncie, Ind.

Circle 568 on Page 19

Adapter Fittings

permit making complex manifolds

Swagelok adapter tees, elbows, and crosses can be connected into any standard Swagelok tube fitting without using intermediate lengths of tubing. Complex manifolds can be made easily, are leakproof, save space, and reduce connection time. Tees and elbows can be aligned in



the direction of the intended tubing runs. Fittings are available in sizes from $\frac{1}{8}$ to 1 in. in machineable

specify accurate instruments

TO MATCH THE QUALITY OF YOUR PRODUCTS

The quality of many a product is complemented by quality instrumentation. That is why many new machines come equipped with American Thermometers, Ashcroft Pressure Gauges, and American Temperature and Pressure Regulators.

We produce these temperature and pressure indicating and regulating devices in great variety for application by original equipment manufacturers. The reliable service these instruments give is also appreciated wherever industry must measure and regulate process temperatures and pressures.

Complete specifications available on request. Mail the coupon for catalogs.

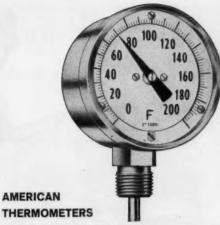


Fastest response is provided by these American Regulators because: 1) the stem can't bind and retard valve action; 2) a bellows seals off the stem and makes practical a non-leaking packless valve. They are self-operated – need no outside power to control temperatures and pressures. Maximum use is made of stainless steel and bronze. Regulator sizes: For temperature—½" to 4". For pressure—½" to 2". Operational ranges: temperatures as low as -15°F. to 50°F.; as high as 240°F. to 340°F. Pressure—250 lb. design.

MANNING, MAXWELL & MOORE, INC.



Gauge and Instrument Division • Stratford, Connecticut Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario



Two outstanding characteristics of these American Bi-Metal Thermometers are 1) precision manufacture to assure sustained accuracy; 2) the unique Maxivision® dial that eliminates parallax errors. Stainless steel construction safeguards against corrosion. Hermetically-sealed models meet the severest service conditions. Dial sizes: 2", 3", and 5". Temperature ranges to suit the application. All types of connections. Stems to 24"; wells to fit all lengths.



These Ashcroft Steel Case Gauges are used on many portable compressors, pumps, and regular pressure lines. They are Bourdon-tube-equipped gauges in pressure, vacuum, and compound types. Brass movement is of precision design. Special heavy-duty movements also available. Pressures range from 15 psi to 600 psi. Dial sizes: 2", 2½", and 3½". Pulsation dampeners, gauge savers, needle valves, and other accessories available. Make your selections to fit the application. Other gauges in the Ashcroft line include Duragauge, Maxisafe, pneumatic receiver, recording, chemical, test gauges, and master reference gauges.

Manning, Maxwell & Me	oore, Inc.
East Main Street, Stratfo	ord, Connecticut
Send me the items checked	below:
☐ American Bi-Metal Ther	rmometer Catalog 155
☐ American Thermometer	Catalog 100B
☐ Ashcroft Gauge Catalog	300B
☐ American Regulator Bul	lletins 114C and 116
Name	
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... a line of industry-wide favorites, built to make tough applications seem easy

When it comes to building electric motor-powered equipment, make sure of your horsepower source. Before you specify any motor brand, consult with your A. O. Smith Motor Man. He'll show you how the horses of A. O. Smith (a full line of integrals and fractionals both polyphase and single-phase) help users surmount application barriers.

And A. O. Smith delivers the horses that deliver the goods — 24-48 hour action on all parts and service orders.



A CASE IN POINT



CHANGED HORSES

Mr. V. F. Radde, President of Skidmore Corporation, reports, "Our condensate pumps are invariably located near boiler rooms and frequently in an atmosphere full of dirt and coal dust. This A. O. Smith motor is the only capacitor start motor we've found that we can use in this kind of service."

Sure, we asked Mr. Radde for this testimonial . . . because we knew he had changed horses . . . switched to A. O. Smith motors because of troubles he had experienced with other makes. And more important, he was glad to do so because the sealed-capsule motor had eliminated his problems. In contrast to every other make, the canopy housing totally encloses the starting capacitor, mounting switch, actuator and automatic overload protector from insects, coal dust, dirt and other impurities.

Furthermore, in addition to superior mechanical features, it's a motor designed specifically for centrii igal pump operation . . . higher performance at full and service-factor loads means higher performance for your pump. It adds up! Mechanically and electrically, you get more motor from the same sales dollar when you put your money on the horses of A. O. Smith.



GO-TOGETHERS - Dependable Skidmore condensation pumps powered by A. O. Smith vertical close-coupled pump motors.

metals and plastics. Crawford Fitting Co., 884 E. 140th St., Cleveland 10, Ohio.

Circle 569 on Page 19

Drum Dials and Verniers

in 11/2, 2, 21/2, 3-in. sizes

Drum dials and verniers, calibrated for 1.0, 1.8, 2.0, and 3.6 deg, are available from stock in 1½, 2, 2½, and 3-in. sizes, respectively. Vernier can read 1/10 deg, 6 min, and 15 min. Concentricity between 0.3750in. diam hole and OD of drum is held to 0.0015 in. TIR. Open side



of drum can be to left or to right. Ackerman Engravers, 458 Broadway, New York, N. Y.

Circle 570 on Page 19

Printed Circuits

alumina-base elements withstand 1300 F

High-reliability printed circuits utilize a 97 per cent alumina base with a fired molybdenum-manganese circuit pattern. Typical of the printed circuits is a rectangle measuring $2\frac{1}{2}$ by 5 in. with thickness of 0.060 in. It provides 42 slots for mounting components, and three holes at each end for mounting the circuitry. As many as five circuit paths in a 1/4-in. square area, with circuit paths separated by as little as 0.005 in., can be produced. Molybdenum-manganese circuit wiring, permanently bonded to the ceramic base, cannot be removed without destroying the ceramic, which withstands 20,000 psi, nor can it be broken or shaken from the circuit board. Frequent field changes can be made without harm to the circuitry. Circuits operate in temperatures to 1300 F and return to their original shapes after exposure to high temperatures. Because of

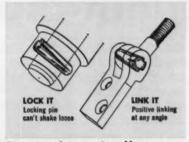


To join two parts as one...

THE SOLID GROOV-PIN

Every one of the Groov-Pins shown here was designed with your pin problems in mind. Designed to withstand the rigors of constant shock and vibration without loosening...to drive easily into a simple drilled hole...for faster hand or production feeding, including hopper feed...for a permanent connection that stands up to vibration fatigue as only a solid pin can.

Groov-Pins are made to meet your requirements, too. Standard sizes run from 1/32 to 1/2", specials to fit your needs at standard prices over 5,000 pieces. Send for illustrated catalog, free samples.

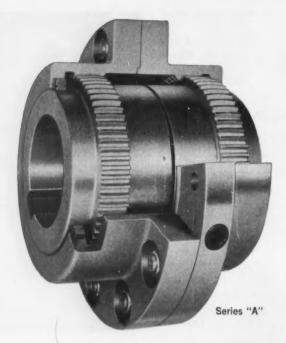


No matter what your pin problem, there's a Groov-Pin to solve it for you.

GROOV-PIN CORPORATION

1130 Hendricks Causeway Ridgefield, N. J. WHitney 5-6780





Forged steel, lube-tight gear couplings

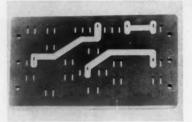
Both hubs and sleeves of these rugged Waldron standard "Series A" couplings are made of forged steel, and the two one-piece cover sleeves function as a single unit. There are no flexible parts to bend or break. At the same time, the grease-tight, patented Walflex seal is placed where the pressure is least, to prevent lubrication problems. You can get prompt delivery of any of the sizes listed below. Write for bulletin S-1000.

Size and nominal bore	Max. over bore	HP/100 rpm	Max.
1¼A	13/8	6	12,000
2A	21/8	21	10,000
21/2A	25/8	45	9,000
3A	31/6	87	7,500
31/2A	3¾	150	6,500
4A	41/4	225	6,000
41/2A	43/4	365	5,300
5A	51/2	525	4,700
51/2A	6	717	4,300
6A	65%	962	4,000
7A	71/2	1137	3,300

WALDRON-HARTIG, Box 791, New Brunswick, N. J. a division of Midland-Ross Corporation







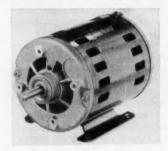
its ability to operate in high ambient temperatures, circuit carries a greater electrical load than circuits made from other materials. Ceramics International Corp., 39 Siding Place, Mahwah, N. J.

Circle 571 on Page 19

Small Induction Motors

have two new mounting styles

New solid-base and four-boss endmountings have been added to improved line of 37/8-in. diam small induction motors. Other improvements include use of Class B material for stator core insulation to ground, improved electrical performance, and an epoxy blue-gray varnish treatment for windings and stator shell finish. Line of compact, ten-frame motors is available in two-pole designs through 1/3 hp and



through 1/8 hp in four-pole, singlephase designs in both horizontal and all-angle sleeve bearing open General Electric motors. Schenectady 5, N. Y.

Circle 572 on Page 19

Flange Bearing

in shaft sizes from 1/2 to 1 7/16 in. OD

FLCT ball bearing consists of a compact cast-iron housing with a standard inner-ring ball bearing and self-locking collar. Combina-



NEW SIZE RANGE SURPRISE!

HERE'S A NEW PROCESS in centrifugally spun tubing that offers you greater freedom in design. It's ACIPCO CERAM-SPUN®...the new ceramic mold process* that is not limited by equipment sizes!

NOW, YOU CAN ORDER almost any combination of sizes you require. ACIPCO CERAM-SPUN® tubes offer O.D.'s from 2.25" to 50"; and wall thicknesses from .25" to 8". As-cast lengths are furnished from 4 feet to 20 feet, longer lengths are made by welding.

THINK OF HOW MUCH this process can save you! You'll avoid the cost of unnecessary metal waste, and

excessive machining charges. And ACIPCO's complete "under one roof" operations — including heat treating, machining and welding — offer many additional economies. No need for the delays and excessive costs that often result in buying from multiple sources.

If you design, manufacture or use tubular component parts, it will certainly pay you to investigate the versatility of ACIPCO CERAM-SPUN® tubing and the flexibility of ACIPCO's integrated facilities. Contact ACIPCO STEEL PRODUCTS, Division of American Cast Iron Pipe Company, Birmingham 2, Alabama.

*Patent applied for

ACIPCO CERAM-SPUN® STEEL TUBING



Circle 342 on Page 19



Are Small Precision Metal Parts Getting In Your Hair?

If you need precision in small metal parts you can get it from Torrington—plus exactly the right finish, temper and hardness required for your needs. Moreover, Torrington can produce such parts at high speed and a remarkably economical cost. We are the leading specialist in this field—with the specialized skills, engineering experience and facilities to save you money. If you have small parts to be manufactured in large quantities why not let Torrington solve your entire problem. Let us hear from you and your request will receive prompt action.

progress through precision SPECIAL METAL PARTS

THE TORRINGTON COMPANY

Torrington, Conn.



tion of square and round bolt holes accommodates carriage bolts or standard machine bolts. Bearing face on the collar is located flush with the face of the casting so that water will not puddle when mounted for vertical shaft applications. Frame side is recessed to allow water or dirt to by-pass, as well as to prevent build-up of air pressure against the bearing seal. Unit is available in shaft sizes from ½ to 1 7/16 in. OD except for 13/16 in. OD. Fafnir Bearing Co., 37 Booth St., New Britain, Conn.

Circle 573 on Page 19

Silicone-Rubber Compound

for wire and cable insulation

SE-9007 silicone-rubber compound is designed for high-quality aircraft, hook-up, motor-lead, and similar wire applications. It has good processing characteristics, easy milling, high extrusion speeds, and good diameter control. Typical physical properties as extruded on wire are tensile strength, 1200 psi, and elongation, 425 per cent. Silicone Products Dept., General Electric Co., Waterford, N. Y.

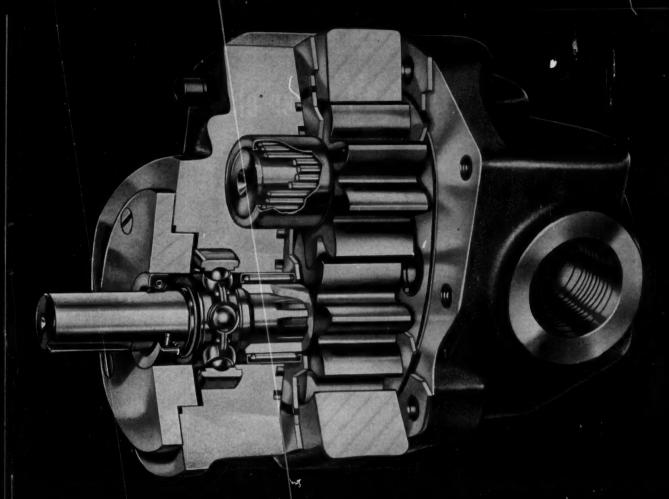
Circle 574 on Page 19

Bimetal Disc Thermostat

for use at temperatures to 350 F

Type 24T Therm-O-Disc is a snapaction unit which provides accurate repeatability over 100,000 cycles at





POWER for the biggest mobile rigs, toughest jobs!

WEBSTER "JD" SERIES HYDRAULIC PUMP

Match your big equipment to the most rugged duty with this newest Webster and you come up with some interesting answers in hydraulic performance. Fluid power up to 2000 psi! Requires less input horse-power! Saves fuel!

This sectioned view and the specifications at right tell the story. The "JD" Series' anti-friction bearings save power, pressure balanced wear plates assure high volumetric efficiency—other equally important features mean extra work output, trouble-free operation!

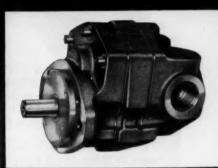
Webster Electric "JD" Series Pump is a trim, very compact unit designed to fit in tight locations. Ideal for agricultural, construction, industrial, utility equipment — machine tools as well. It's available in 5 sizes from 5 to 17 gpm — attaches easily with a choice of mountings. Ask your Webster Electric representative for all the facts on this powerful new pump — or write direct for engineering detailed sheet HY1-2.

OIL HYDRAULICS DIVISION

WEBSTER



Circle 344 on Page 19



SPECIFICATIONS

Capacity: 5 sizes, 5 to 17 gpm.

Operating Pressure: Up to 2000 psi.

Operating Speed: Up to 2400 rpm.

Wear Plates: Pressure balanced — prevent clearance changes from heat.

Bearings: 4 anti-friction needle bearings save power or fuel. Ball bearings on drive shaft to absorb end thrust.

Gears: Smooth-running, spur cut. One piece gear and bearing journal units assure minimum deflection and proper alignment.

Drive: Free-floating internal spline — eliminates key failures.

Seal: Double lip on drive shaft — added protection from seal failure and dirt.

Porting: End, side, or bottom.

Mounting: SAE Type A, 2-bolt mounting flange standard. Foot mounting optional.



DIAMOND CHAIN COMPANY, INC.

A Subsidiary of American Steel Foundries

Dept. No. 435 • 402 Kentucky Avenue
Indianapolis 7, Indiana

Look under "Chains" or "Chains, Roller" in the Yellow Pages for your nearest DIAMOND Distributor



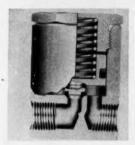
temperatures to 350 F for 10 amp resistive or ½ hp inductive, at 120/240 v ac. Compact unit withstands rough handling and use. It is available with enclosed or exposed bimental disc and various mounting flanges and terminal arrangements. Therm-O-Disc Inc., Mansfield, Ohio.

Circle 575 on Page 19

Relief Valves

for pressures to 2000 psi

P-458 Priority relief valve provides complete isolation of any portion of hydraulic or pneumatic systems below a preset point. Operating at pressures to 2000 psi, valve is externally referenced with actuation accomplished by absolute system pressure rather than differential



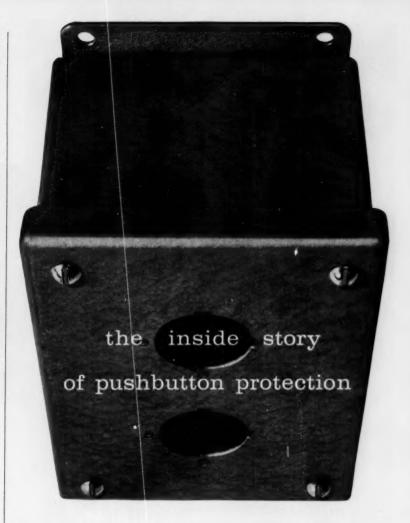
pressure between inlet and outlet. Fail-safe valve closure is effected by positive spring pressure whenever downstream pressure. Above preset pressure, valve is full open, permitting flow to downstream system with virtually zero drop. Valve body of aluminum with chromic anodize finish has \(^1_4\)-in. female pipe connections. Circle Seal Products Co. Inc., 2181 E. Foothill Blvd., Pasadena, Calif.

Circle 576 on Page 19

Electrical Connectors

in 15, 18, 21, 24, 27, 30, and 33-contact configurations

Series 3300 Beauplugs are electrical connectors rated at 750 v rms with a current capacity of 10 amp. Manufactured in 15, 18, 21, 24, 27, 30, and 33-contact configurations, they are used in telephone switchgear, automatic vending machines, communications equipment, and electri-



The story is, that both inside and out—Keystone pushbutton enclosures are carefully built to give maximum protection for electrical controls.

All are rigidly produced to JIC and Nema standards, and they're all stocked in a wide variety of sizes and styles to meet your exact wiring requirements. Special sizes can also be quickly produced for unusual applications.

Next time you're in the market for top quality enclosures, take a close look at Keystone . . . and get the whole story!

Write for your new Keystone Catalog of JIC and Nema 12 Wiring Enclosures







KEYSTONE

MANUFACTURING COMPANY

DIVISION OF AVIS INDUSTRIAL CORPORATION
23332 Sherwood Ave. • Warren, Michigan

June 22, 1961

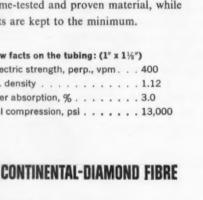
Familiar product . . . new use

In the hands of experts, a well-known product has found a new use, brought about by today's fast moving technology. A spacer with electrical insulating and special mechanical properties was required for this stud-mounted power transistor. CDF solved the problem with paper phenolic rolled tubing, a longestablished grade. Fabrication of the spacer is accurate and low cost on automatic screw machines.

Result: Reliability is assured through use of a time-tested and proven material, while costs are kept to the minimum.

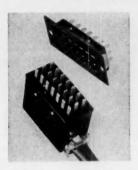
A few facts on the tubing: $(1" \times 1\%")$

Dielectric strength, perp., vpm . . . 400 Min. density 1.12 Water absorption, % 3.0 Axial compression, psi 13,000









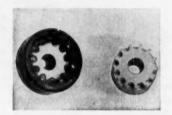
cal and electronic instruments. Linear polyethylene backshell provides protection against moisture and dust, and has excellent appearance, dielectric strength, and shelf life. Beauchaine & Sons Inc., Lakeport, N. H.

Circle 577 on Page 19

Flexible Coupling

is cushioned in urethane rubber

Splineflex coupling, a shock-absorbing, flexible unit, designed to compensate for angular and parallel misalignment, is cushioned in water and oil-resistant urethane rubber. Rubber center member is made up of a series of metal parts molded in the rubber; load is distributed evenly throughout the flexible center. Hubs can be separated by ½



in. with no problems. Urethane rubber is stable from -80 to 275 F and resists oxygen, ozone, oil, and water. Olson Industrial Products Inc., 40 W. Water St., Wakefield, Mass.

Circle 578 on Page 19

Air and Hydraulic Cylinders

have full cartridge rod bearing

Air and hydraulic cylinders, available in 11 bore sizes from 1½ to 14 in., have a new cartridge rod bearing which incorporates a metal





Racine Hydraulics & Machinery, Inc.

ACINE, WISCONSIN

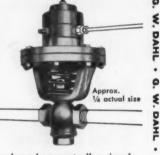
HYDRAULICS DIVISION



Circle 349 on Page 19

G. W. DAHL . G. W. DAHL . G. W. DAHL . G. W. DAHL . G. W. DAHL

PACKAGED PNEUMATIC RELAY MONITORS CONTROL SIGNALS!



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DAHL

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DAHL

Dahl MITE 70... versatile twoway, snap-acting control relay ... can be integrally mounted on Dahl control valves or used elsewhere in control circuits on air or non-toxic gas applications.

Rugged MITE 70 offers variety of control actions at settings from 1 to 100 psig. Crisp tripping action (on either increasing or decreasing signal) vents one control circuit while locking up a second. Can be set to trigger an alarm while locking

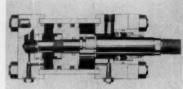
up a valve when controller signal reaches predetermined set point. For positive, reliable actuation of diaphragm motor valve operators, air cylinders, or other pneumatic control elements.

Features include safety trip-out with manual reset . . . compact size (2½" dia. x 3½" high) . . . temperature limits from -40°F to +180°F. Request Bulletin M-70 for complete details. G. W. Dahl Co., '83 Tupelo Street, Bristol, Rhode Island.

G. W. DAHL CO., INC.

SPECIALISTS IN COMPACT VALVES AND CONTROLS

G. W. DAHL . G. W. DAHL . G. W. DAHL . G. W. DAHL



rod scraper and a rubber rod wiper to protect against chips and dirt. Cartridge rod bearing can be removed without removing cylinder from its mount and without disassembling the cylinder. Units are for 200 psi air and 250/500 psi hydraulic service. Carter Controls Inc., 2914 Bernice Rd., Lansing, Ill.

Circle 579 on Page 19

Roller Chain

has high capacity, fewer wearing surfaces

New Bowman chain, with a redesign of the elements in conventional roller chain, has 40 per cent fewer wearing surfaces, reduction of 33½, per cent in wearing parts, 39 per cent greater bearing area, and 66 per cent more pin capacity. Chain can be turned over for extra wear life, and is recommended for use on hardened sprockets. Ultimate tensile strength or actual



breaking load has been increased about 58 per cent over conventional chain. Chain is now available in 2-in. pitch size. Jeffrey Mfg. Co., Columbus, Ohio.

Circle 580 on Page 19

Pressure-Vacuum Control

for operation to 500 psi

Type H41 calibrated pressure-vacuum control is available for use on a wide variety of applications such as sterilizers, centrifuges, welding equipment, panelboards, and process-control equipment. Control is designed without an enclosure for direct incorporation into equipment. Several adjustable ranges are avail-

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This new engineering bulletin leads you right to the hydraulic pump designs you may be looking for. Here, passing on parade, are high performance gear pumps made to the measure of the next generation in aircraft, missiles, spacecraft, and support equipment.

Many of these units are the product of ready-made, mass-produced components that can be teamed into the precise configuration you need. Custom-designed pumps are also available.

All have in common these classic Eastern hydraulic pump characteristics:

SMALL SIZE: Eastern gear pumps are the smallest, lightest made. Airborne servo system pump shown delivers 1.5 gpm @ 1500 psig — measures only 11/8" x 11/8" x 23/4", weighs 9 oz.

WIDE PERFORMANCE RANGE: pumps available have theoretical displacement from .0016 to 1.30 cu. in. per revolution—flow from .025 to 9.6 gpm, pressures from 0 to 2000 psig, at speeds to 24,000 rpm. Weights with motor range from 1.5 to 8.5 lbs.

UNAFFECTED BY EXTREME ENVIRONMENTS: rugged, reliable Eastern units take loads to 50g in stride — shrug off temperature differentials to meet MIL specs.



EASTERN INDUSTRIES INCORPORATED

100 SKIFF STREET • HAMDEN 14, CONNECTICUT WEST COAST OFFICE • 4203 SPENCER ST. • TORRANCE, CALIF.

Other Eastern products:

- hydraulic motors
- servovalves, amplifiers,
 actuators and systems
- actuators and systems
 pressurization/dehydration
 packs
- quick-disconnect couplings
- electronic tube cooling units





able within limits of 30 in. Hg and 500 psi, with on-off differentials from $1.5 \pm \frac{1}{2}$ in. Hg to 10 ± 3 psi. Switch action includes normally open, closed, and double throw, suitable for ambients to 180 F. Standard electrical ratings are 15 and 20 amp, 115/230 v ac. United Electric Controls Co., Dept. N, 85 School St., Watertown 72, Mass.

Circle 581 on Page 19

Chemical Paste

cleans and treats aluminum surfaces

EX-B727-6, a translucent, organic paste which provides a combination cleaner and surface treatment for aluminum, is easily applied by spraying, brushing, or wiping. Chemical reactions which occur during drying produce an organic conversion coating on the metal surface. Rinsing off the dried paste leaves a surface with high adhesive properties for bonding or coating. Paste also serves as a surface cleaner for stainless steel and chromeplated surfaces. It has proved effective for promoting adhesion on highly stressed, bonded-aluminum panels and airframe sections. Hughson Chemical Co., Div., Lord Mfg. Co., Dept. 88C, Erie, Pa.

Circle 582 on Page 19

Spiral-Wrap Hose

for working pressures to 3000 psi

Spiral-wrap hose No. 2755 is suitable tor hydraulic systems where 11/4 to 2-in. hose sizes are required with working pressures to 3000 psi. Hose has a synthetic inner tube with alternating layers of spiral wire wrapping and synthetic rubber. Segmented fittings developed for use with the hose can be assembled quickly with simple hand



for quotations invited.

New two-stage and single-stage 10,000 P.S.I. hydraulic pumps and power packages also available.

YS-SERIES SPRING RETURN 7-9,500 P.S.I. 2, 4, 7, 10, 20, WRITE FOR FREE ENGINEERING DATA FILE CATALOG



PRECISION HYDRAULICS DIVISION OWATONNA TOOL CO.





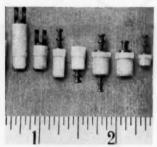
tools. Hose need not be skived to attach fittings. Fittings are leakproof and blowoff-proof, yet are completely detachable and reusable. Aeroquip Corp., Jackson, Mich.

Circle 583 on Page 19

Teflon-Insulated Terminals

are available in four new types

Line of Teflon-insulated terminals includes 138 varieties of four new types of press-mount units: Reverse feed-through, feed-through, reverse stand-off, and stand-off. Terminals are available in single and double-turret, combination single and double-turret, combination spade and single-turret, and pin types in Series 4000, 4100, 4200. Each of the four new terminals is



available in seven configurations. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.

Circle 584 on Page 19

Solenoid Valve

operates at rates to 1000 cpm

Compact, high-pressure VO46A solenoid valve for use in fluid (liquid and gas) control operates at pressures to 200 psi in temperatures from -65 to +350 F. Valve is available in: 6 to 64-v dc; 6, 12, 24, and 110-220 v 60-cycle ac; and 110-v, 400-cycle ac models. It operates in any position with a maximum rate of 1000 cpm at 100 psi.

SOME TIMERS DO ALL THEY ARE DESIGNED FOR-AND MORE. Others just make claims. A. W. Haydon's record speaks for itself. Behind each: 101 "pros" pooling their timing technology...sophisticated test labs to assure peak performance ... built-in reliability reflecting years of experience. A.W. Haydon makes them all: timing motors, time delay relays, elapsed time indicators and the like-electronic marvels from Culver City, electromechanical wonders from Waterbury. Shown: Push-to-start interval timer for industrial use—write for bulletin. If a timer's at the heart of your product, don't "buy cheap". Pennies saved here can be headaches earned later-complaints, returns, poor performance. When it's a matter of time, choose A. W. Haydon reliability.

PERFORMANCE OUTWEIGHS CLAIM



you manufacture:

Air conditioning, appliances, electronic, communications, electrical apparatus, fans, blowers, machine tools, materials handling, panelboards and switch boards, prime mover, pumps, compressors and general machinery . . .

these Westinghouse products are tailored for you

On these pages are shown some of the many components developed and manufactured by Westinghouse specifically for OEMs. Here is one single source for technical assistance, manufacturing and stocking of all of your electrical needs. Use this total service to solve your design and manufacturing problems now. Call your local Westinghouse Sales Engineer or write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.





Black Line control transformers

Especially designed for machine tool control. Compact design plus Westinghouse's exclusive "BONDAR" Class "A" insulation combines quality and minimum space in Black Line Transformers. Offered in a wide range of voltage ratings—.025 kva through 5 kva with a 55° C. rise. For details, write for Bulletin B-7879 to Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse. J-96170

Circle 354 on Page 19

Inlet connection is 1/2 in. NPT, and outlet connection is 1/8 in. NPT. Over-all length is 25% in. with a diameter of 13/8 in., and weight is 5 oz. Standard lead lengths to 24 in. are available. General Magnetics Inc., 2641 S. Louisiana Ave., Minneapolis 26, Minn.

Circle 585 on Page 19

Pillow Block

is now available in 1/2 through 1-in. shaft sizes

All-purpose, strap-type pillow block, Series 1330-1338, is now available in shaft sizes 1/2 through 1 in., increasing the range of sizes from 1/2 through 2 3/16 in. Detent arrangement holds the 16-gage, cadmium-plated cap and base together until mounting bolts are installed. Either a sintered-bronze or graphited bushing is furnished. Randall Graphite Bearings Inc., Box 839, Lima, Ohio.

Circle 586 on Page 19

Flexible Coupling

for applications with high torque requirements

Heavy-duty Para-Flex flexible-cushion coupling has more than twice the torque capacity of the next smaller size. It features standard, tire-shaped flexing element to ac-





BF relay

Saves space, cuts cost, is specially engineered for machine tools. 50% less space, front accessible terminals, low temperature operation, lower installed cost, long life. In both 4-pole and 8-pole frames, rated at full load current of 6 amps/300 volts a-c 60 amp inrush. Write for Bulletin B-7345, Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse. Circle 355 on Page 19





Oil-Tite pushbuttons

Simple, rugged, contaminationproof. Flush oil-tite pushbuttons with minimum projection keep oil, coolant, cutting oil or water from contacts. Wide variety of head types and interchange-able color caps make this one of the most flexible lines of pushbuttons available today. Write for Bulletin B-7321, Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

NEW



Guardistor motors

Guaranteed against burnout due to overheating from any cause! Exclusive static-semiconductors imbedded in windings respond with snap action only when windings reach critical temperature. Anticipated nuisance trips are avoided. Use full rated hp safely. Available for any size motor. Write for Bulletin B-7876 to Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse. Circle 357 on Page 19





AVR adjustable speed drives

Static design, less floor space, easy installation, flexible. System converts a-c to d-c to operate an adjustable speed d-c motor. Includes a power unit, main d-c drive motor and operator's control station. Available from 1 to 200 hp or larger. Write for Bulletin 5601 to Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse. 1-96172

commodate angular and parallel shaft misalignment and to absorb end float, shock, and vibration. The PX280 handles 400 hp per 100 rpm; capacity at maximum recommended speed of 910 rpm is 3640 hp. Coupling is available from stock with Taper-Lock bushings for shafts to 7 in. in diam. Dodge Mfg. Corp., Mishawaka, Ind.

Circle 587 on Page 19

Slide Switches

for use on instruments and small appliances

Series 1940 and 1960 slide switches are single-pole, two-hole-mounting. ac, compact units for use on instruments and small appliances. Nonwelding solid silver-alloy contacts, silver-plated rockets, and com-



plete mechanism are entirely enclosed in a high-impact, thermosetting plastic case. Electrical ratings for 1940 Series are: 10 amp, 250 v ac; 15 amp, 125 v ac; 1/2 hp, 120-240 v ac. In the 1960 Series, ratings are 3 amp, 25 v ac; 6 amp, 125 v ac; and 1/4 hp, 120-240 v ac. Circle F Mfg. Co., Trenton 4, N. J.

Circle 588 on Page 19

Miniature Valve

has positive bonnet lock

SSG 106-2L miniature valve is for use with oxygen, nitrogen, helium, air, fuels, hydraulic oils, and chemicals. Valve, which has a bonnet lock, is 3/4 in. wide, 17/8 in. long, and about 2 in. high in open position. Operating temperature range is from -65 to +250 F, for highvacuum to 3500-psi service, with shut-off torque of 6 lb-in. at 2000 psi. Construction is stainless steel.



Rectiflow adjustable speed drives

Economical, simple, reliable, over 3:1 speed range or higher, inherent constant hp characteristics. 20 hp to 600 hp in open and totally enclosed air-cooled designs. Inherent fast response and close speed regulators make this drive a natural for a wide variety of machine tool applications. For more information, write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

Circle 359 on Page 19



Westinghouse



fractional hp

Operates 25,000 hours without re-oiling on light duty applications, uses specially designed sleeve bearing lubrication system. Over 550 motor styles rated 1/8 to 1 hp in variety of combinations of mechanical features are stocked by Westinghouse at all times to meet your instant needs. Write for Bulletins 2820 and 2850 to Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse. 1-96173

Circle 360 on Page 19



Forms of the NEG'ATOR Spring



NEG'ATOR® springs start from a flat strip of selected stainless or high carbon spring steel.



After special prestressing and thermal processing, the NEG'ATOR band exhibits a powerful tendency to curl—uniform throughout its length.



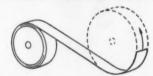
Rolled onto a bushing, it makes a long, constant-force spring because it resists unrolling with a uniform pull—the same force at any length.



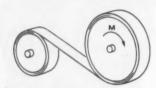
When both ends of the NEG'ATOR band are allowed to form loops, the band becomes a *clamp* of widely adjustable opening and unvarying clamping pressure.



A single or partial coil becomes a strong, resilient *clip* that can be opened completely—even straightened—without permanent deformation.



By reverse-winding the free end around a second, larger drum, we utilize the tendency of the material to recurl to its preset curvature.



The constant output torque available at the shaft of the larger drum provides a powerful, long-running NEG'ATOR motor.

How to use it?

■ Movie cameras, electric brush holders, appliance cord retrievers, window sash balances and countless other mechanical and electrical products well known to you now employ NEG'ATOR springs. Write for literature.

The NEG'ATOR spring is a development of Hunter Spring Company.



HUNTER SPRING COMPANY

A Division of American Machine and Metals, Inc.

3 Spring Avenue, Lansdale, Pennsylvania

DIVISIONS OF AMERICAN MACHINE AND METALS, INC.: Troy Laundor Machinery Righte Testing Machines • De Bothezat Fans • Tolhurst Centrifugals • Filtration Engineers • Filtration Fabrics Niegara Filters • United States Gauge • Rehm Instruments • Lamb Electric Co. • Hunter Spring Co. • Gleser-Steers Corp.

NEW PARTS AND MATERIALS



and weight is less than 5 oz. Robbins Aviation Inc., 2350 E. 38th St., Los Angeles 58, Calif.

Circle 589 on Page 19

Insulated Thermostat

has long bimetal-actuated contact

Application dictates the minimum differential consistent with the smallest size in Model HB insulated thermostat. Long bimetal-actuated contact makes possible a maximum differential of less than ½ deg C. Case is insulated by means of two glass-seal solder terminals. Unit can be calibrated and hermetically sealed



at the factory or by the customer. Chatham Controls Corp., 156 River Rd., Chatham, N. J.

Circle 590 on Page 19

Pipe-Thread Fitting

for pipe sizes from 1 to 3 in.

O-ring pipe-thread fitting with NPTF female thread is a weld-type hydraulic fitting which provides flexibility in pipe and tubing assemblies. Fitting, available for pipe sizes from ½ to 3 in., goes on standard pipe and provides connection from pipe to SAE four-bolt, flange-type connectors, thus eliminating thread-type connections. Anchor Coupling Co. Inc., Dept. PR-11, 342 N. Fourth St., Libertyville, Ill.

Circle 591 on Page 19

Improve your bearing designs with this wide choice of

ORANGE NEEDLE ROLLER BEARINGS

Gives you broader opportunity to

- simplify your designs
- meet load requirements
- save space, weight and cost

ORANGE Full Type ROLLER BUSHINGS

These heavy-duty full type needle bearings have rollers and races made of finest bearing steel—hardened, ground and finished to highest precision standards. Maximum load capacity in small space. Stocked in standard, interchangeable sizes from 1/2" to 8" shaft diameters.





With or without inner race





Double and Triple Row Types for extra-heavy duty

ORANGE Cage Type NEEDLE BEARINGS

Precision needle rollers are permanently aligned in antifriction cage to prevent roller skewing. Adapted to overhung mountings, vertical mountings, relatively high speeds and conditions of shaft deflection and misaligned housings. High load capacity and smooth, quiet running. Choice of cage designs to suit application. Available from stock in standard, interchangeable sizes from ½" to 8" shaft diameters.





With or without inner race

with or without their race



O

Cage and Roller Assembly

Used without races to save space and cost where shaft and housing are hardened and

MC Series

Longer, larger diameter rollers give increased capacity — yet interchangeable with standard needle bearings.

HS Series

Heavier sectioned larger rollers— higher capacity, Inch sizes between standard needle and cylindrical roller heavings.



Double or Triple Row Types for extra-heavy duty



ORANGE CAM FOLLOWERS





ORANGE CAM YOKE ROLLERS



SPECIAL ADAPTATIONS AVAILABLE

All Orango Heedle Bearings can be made of special metals and special sizes and constructions to meet your requirements. Submit specifications.

WRITE FOR 44-PAGE CATALOG

giving details, dimensions, load ratings, shaft and housing telerances on Orange Needle Bearings and other Orange Relies Bearings.



ORANGE ROLLER BEARING CO., Inc. 556 Main Street, Orange, N. J.

Needle Bearings — Staggered Roller Bearings Journal Roller Bearings — Thrust Roller Bearings Cam Fellowers



FROM DOMESTIC HOT WATER UNITS...



TO ATOMIC STEAM GENERATING EQUIPMENT

Here's versatility at its peak . . . in Vulcan's wide range of electric immersion heaters for industry, commerce and home. They range all the way from 100 to 500,000 watts in standard voltages. Units are readily adaptable to thermostatic control. Moisture-proof, dust-proof or explosive-proof construction is available. Heaters are designed for all types of fluids . . . water, oil, steam, air, Dowtherm, etc. And they're also available as packaged units, complete with shells and jackets.

Write for Catalog VG-201.



Circle 363 on Page 19

ENGINEERING DEPARTMENT

EOUIPMENT

Miniature Tachometer

checks both constant and changing speed

Photo Tachometer requires no external power source and no electrical or mechanical connection with the product being measured. Unit is built around a light-sensitive photoelectric cell which responds to minute illumination changes and transmits a signal to a pulse-triggered computer. Computer determines the speed and displays the



result on a direct-reading meter dial. All speeds from 0 to 12,000 rpm, of both constant and changing-speed equipment, are recorded. Power is provided to the computer by standard mercury batteries and to the light beam by penlight cells. Pioneer Electric & Research Corp., 743 Circle Ave., Forest Park, Ill.

Circle 592 on Page 19

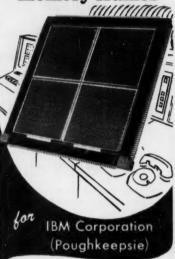
Drafting Table

permits complete board counterbalance

Torsion Auto-Shift drafting table provides complete adjustability of board position, allowing the draftsman to work in a comfortable, fatigue-reducing position. Drawingboard tilt mechanism allows complete board counterbalance through use of a torsion bar. Counterbalance is easily adjustable to provide for additional weight of drafting machines. All operating mechanisms are completely enclosed in the base example...

FIBERITE

at work in computer memory frames



Memory-core frames are a vital part of IBM's fabulous computers.

These frames hold and protect the tiny "memory units" which store information for processing.

IBM Poughkeepsie, working with Fiberite Corporation, specified a reinforced plastic frame material with these characteristics:

- The ultimate in dimensional stability under widely varying atmospheric conditions
- High impact and flexural strength
- Minimum shrinkage values
- High dielectric strength
- High heat resistance
- Good molding characteristics
- Automatically preformable

With Fiberite compound F.M. 4005, the exact formulation was achieved through the intense cooperation of Fiberite research engineers and their counterparts at IBM. Results have been called "outstanding."

Your firm, too, can benefit from Fiberite's experience, skill and imagination. Special applications to fit special problems are Fiberite's stockin-trade.

Why not get complete in-formation on how Fiberite can work for you. Write today for details, and ask also for your free catalog. Today is not too soon! FIBERITE CORPORATION

Linde Coatings Vews

LINDE COMPANY, DIVISION OF UNION CARBIDE CORPORATION

Surgical shears get longer life with LINDE tungsten carbide coating

Surgical shears with tungsten carbide coated on working surfaces now lose their cutting edge about *one-third* as fast as conventional shears. This has been proven under rigid testing supervised by a leading research laboratory.

The American Medical Instrument Corporation, Flushing, New York, uses the LINDE Flame-Plating process to improve the working surface and increase the wear-resistance properties of shears produced under its *Tuncarb* trade-mark.

The process has increased cutting life to the extent that *Tuncarb* shears in use for more than a year have not as yet been returned to AMICO for sharpening. By comparison, regular surgical shears used under the same conditions had to be returned as many as three times for restoration of working surfaces.

Coatings only .004" thick

AMICO ships hot-drop-forged stainless steel parts to LINDE's new Flame-Plating plant at North Haven, Conn. Here, via the LINDE developed coating process, a .004" thickness of tungsten carbide is actually "welded" to the precision wear surfaces of the instruments.

After coating, the blades and jaws are assembled, riveted, ground, polished, and buffed to a high finish by AMICO. The tungsten carbide surfaces themselves are finished with only a slight brushing. The same process is used to coat *Tuncarb* needle holders to provide tungsten jaws that give a firm grip on needles.

High-speed "blast-on"

The heart of LINDE's coating process is the LINDE Flame-Plating gun, into which exact quantities of oxygen, acetylene, and tungsten carbide or other powdered materials are fed by a special mechanism. After the gun is aimed at the area to be coated, controlled detonations "blast" the particles onto the work piece at speeds up to 2500 fps—until the desired coating thickness is reached.

Although temperatures of about 6000° F are attained within the detonation gun to heat powder to plastic state, the work piece itself is always kept be-



The inside cutting surface of the *Tuncarb* surgical shears shown here have been coated with tungsten carbide, reducing their rate of wear by as much as one-third.

low 400° F during the operation. There are no changes in the properties of the base metal and no distortion of the work piece regardless of its minuteness.

In some uses, depending on the thickness of finish, the LINDE Flame-Plating process has been known to multiply wear resistance of metal parts by as much as 40 times.

For complete information on how you might use this advanced method of coating metals to improve production or reduce operating costs, check and send the coupon below.

LINDE synthetic sapphire solves quide problem in tape recorders

Second only to the diamond in hardness, LINDE synthetic sapphire provides unique wear-resisting characteristics. Because of its extremely low friction, hardness, and physical and chemical stability, several large manufacturers are using LINDE synthetic sapphire to solve the wear problem in tape guides on airborne and high-reliability tape decks, as well as in photographic film guides.

In these areas—where hardened steel guides show friction and wear almost immediately—sapphire wear is nearly imperceptible even after 100 hours of operation.

LINDE flame-polished synthetic sapphire is a convenient material for preventing edge-cutting typical with certain tapes in top and bottom guides.

For details on LINDE synthetic sapphire for any type of wear guide, instrument bearing, or other critical application, check and mail the coupon.

Chromium polished to maximum lustre with LINDE abrasives

In certain applications where it is necessary to achieve an extremely smooth surface on chromium finishes, such as in photographic rolls and processing rolls in the plastics industry, LINDE alumina abrasive powders of 99.98% purity have demonstrated unusual efficiency in removing the most minute protuberances.

Several leading photographic and precision parts manufacturers use LINDE abrasives, not only to obtain high-lustre finishes that protect materials, but also to refinish rolls several times over to avoid frequent replating.

Grades of LINDE alumina powders in sub-micron sizes are available for several cutting speeds or types of finish. For information, use the coupon below.

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Linde Company, Dept. MD-64

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- ☐ LINDE Synthetic Sapphire
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Special bearing super-dampens Rochester bimetal thermometers

A special dampening bearing is used just above the bimetal element in Rochester industrial thermometers. It is a precision machined part which serves several needed dampening functions: it further dampens the bimetal shaft; it helps to prevent coil unwinding and pointer oscillation; it serves as a better guide for perfect shaft alignment within the tube.

The primary reason for dampening bimetallic dial thermometers, of course, is to preserve accurate calibration, especially on the lower temperature ranges where a thinner bimetal element is used. The combined use of a special dampening bearing and silicone makes Rochester thermometers extra resistant to shock and vibration. You get this only in Rochester industrial thermometers.

Write, wire or phone—tell us your requirements for indicating and control instruments—let Rochester Instrument's engineering skill go to work for you. American-Standard Controls Division, ROCHESTER INSTRUMENT PLANT, 229 Rockwood St., Rochester 10, New York.





of the unit. Anodized-aluminum pencil trough has reversible plastic edge. Combined drawing and reference facilities in one unit save floor space, and are accessible from either side. Table permits single, L-type, or row installations without modifications. Hamilton Mfg. Co., Two Rivers, Wis.

Circle 593 on Page 19

DC Power Supplies

are low-voltage, solid-state units

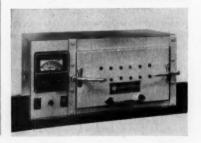
Two miniature solid-state powersupply units have high stability, withstand shock and stress, and operate in continuous temperatures to 100 C. Bench model PS 120 provides low voltages for transistorized circuits and strain gages. Model PS 150 is applicable to filament supply and computers. Both are bench type, with rack mounting also available. Both suppress line transients in less than 10 mu sec, and include pushbutton reset with automatic overload protection. Dynex Industries Inc., 123 Eileen Way, Syosset, N. Y.

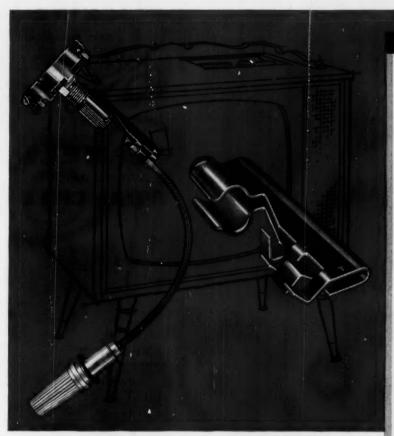
Circle 594 on Page 19

Thermal Shock Chambers

have accuracy of 1/2 deg F

Designed for bench-top operation,





A Tinnerman T-Marked Original ...

SPEED CLIP* gives Sylvania easier, more reliable, more flexible assembly

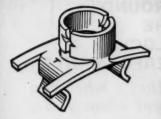
This new Tinnerman-engineered SPEED CLIP fastener provides a faster, more flexible connection between control "pots" and knobs on a TV manufactured by Sylvania Electric Products, Inc. The fastener can be applied wherever similar components are mounted and space limitations pose an assembly problem.

Several advantages are offered over methods previously used. Assembly is easier and faster...mating parts are simply pressed together and secured under live spring tension. Built-in ratcheting action permits overload slippage to protect the control from overadjustment. Designed for use with a flexible cable, mounting of the control is completely independent of the knob location. They can be perpendicular to each other anywhere within 360°. Finally, this fastener is stamped with the Tinnerman T-mark, as are all SPEED NUT* brand fasteners. This is your assurance that Tinnerman quality and total reliability are going into your products wherever these fasteners are specified.

For samples, literature, prices, call your Tinnerman sales office... listed in the "Yellow Pages" under "Fasteners." Or write to: Tinnerman Products, Inc., Department 12, P. O. Box 6688, Cleveland 1, Ohio.



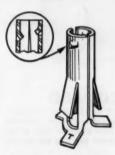
T- MARK ENGINEERED SPECIALS



TRANSISTOR CLIP saves weight and space, snaps quickly into panel ... no screws, rivets. Designed for coil form retention, this SPEED CLIP fastener proved ideal for fastening transistors. Tubular retaining collar has excellent heat sink properties, openings at sides and bottom allow air circulation.



FRONT MOUNTING SPEED CLIP FASTENER cuts front panel assembly costs on popular washer-dryer. Unique self-retaining SPEED CLIP fastener permits simplified front mounting for easier, faster, lower cost assembly of front panel. No welding, staking, screw driving ... ends scrap hazard. Four fasteners engage panel mounting flange as it slips in place over curved spring fingers. Assures firm vibration resistant assembly, yet easy removal for servicing.



BOWDEN CABLE CLIP is one of many Tinnerman designs to fasten armored cable. Designed for car instrument panels, it's the perfect answer to through-panel cable fastening problems. No welding, staking, clinching, no special mounting brackets or clamps. Live spring tension prohibits vibration . . . prevents loosening.

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S.A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano Simmonds GMBH, Heidelberg. that's what you get when you Specify...

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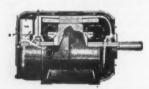
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First of all they are specifically engineered to meet the exacting requirements of most power needs — regardless of type or location. Then too, they insure constant, uninterrupted service in high temperatures because they are always cool running. Having enclosed ball bearings you are assured of complete protection against harmful dust and grit. Furthermore, they can handle most power load emergencies without damage to its operating parts.



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Totally enclosed VALLEY Motor Polyphase, 50 to 60 cycles, constant speed, continuous duty, squirrel cage induction, high torque, lew starting current and fully ball bearing, 2 to 60 h.p.



ELECTRIC CORPORATION

Circle 368 on Page 19

ENGINEERING DEPT. EQUIPMENT

Ultratemp/600 and Ultratemp/800 have a net work area of ½ cu ft. Completely removable, file-drawertype door gives access to the steel chamber, which measures 16 x 8 x 8 in. Model 600 is instrumented for operation between -100 and +500 F with a 5-min pulldown and 30-min warmup. Model 800 has a low temperature of -320 F and a high of +500 F. Each unit is instrumented to an accuracy of ±½ deg F. Cincinnati Sub Zero Products, 3932 Reading Rd., Cincinnati 29, Ohio.

Circle 595 on Page 19

Vertical File

accommodates sheets to 36 x 48 in.

Mobile Plan Rack has a tubularsteel frame and is equipped with ball-bearing casters. It can be adjusted to accommodate sheets up to 36 x 48 in. It is intended for use with 12 Type S binders and



provides for filing up to 1200 sheets. Rack weighs less than 18 lb, and occupies 3 sq ft of floor space. Plan Hold Corp., 5204 Chakemco St., South Gate, Calif.

Circle 596 on Page 19

Reaction Torque Sensor

measures torque by restraining the case of the test device

Model RTS device measures smallmotor torque, bearing friction, stepping-switch torque, torsion spring, rotary-solenoid torque, and drilling torques. Unit measures torque by restraining the case of the test device. This provides true dynamic torque with good frequency response by eliminating the need for in-line torque sensors which change the

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CENTRIFUGAL CASTING ... makes 4 giant stator shells

Specified by Westinghouse for 4 canned motor pumps soon to be integral parts of reactor system in Yankee Atomic Electric Plant in Rowe, Massachusetts

One king-size 17-ton Sandusky casting supplied the main motor bodies (stator shells) for the four pumps being built by Westinghouse, each to handle 23,600 g.p.m. of pressurized water through the reactor

The 25-foot-long Sandusky casting was centrifugally spun of a modified CF-8 (Type 304 L) stainless steel, then machined by Sandusky to a 3" wall thickness, 311/2" on the O.D. This huge casting was hydrostatically tested to 3800 psi before being sectioned into four 68" lengths.

These stator shells represent another new and exacting application for Sandusky Centrifugal Castings-which may offer a practical and economical answer to your cylindrical requirements also. They are available in diameters from 7" to 54"-in lengths up to 33 feet-in heat- and corrosion-resistant stainless, carbon and lowalloy steels and a wide range of copper-base and nickel-base alloys.

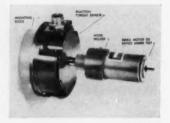
Let us show you how Sandusky Centrifugal Castings can help solve your cylindrical problems. Write to us at Sandusky, Ohio.

CENTRIFUGAL CASTINGS SANDUSKY FOUNDRY & MACHINE CO.

SANDUSKY, OHIO Stainless, Carbon, Low-Alloy Steels -- Full Range Copper-Base, Nickel-Base Alloys



rotating inertia of the system being tested. Sensor can be used in any position. Standard models are available in capacities of 0-10, 0-50, 0-100, 0-200, 0-500, and 0-1000 oz-in.



with 0.25 per cent accuracy. Lebow Associates, 14857 W. Eleven Mile Rd., Oak Park 37, Mich.

Circle 597 on Page 19

Surface-Finish Indicator

measures surfaces from I to 1000 mu in.

Model MS 1000 Surfindicator is a portable, transistorized, battery-powered instrument for measuring surface finishes on metals, plastics, ceramics, and organic materials. Precision measurements from 1 to 1000 mu in. can be made; pick up stylus detects variations of ½ mu in. within the measurement range. Surface-finish measurements are read directly on the Surfindicator meter. Pro-



file of the surface can be obtained by connecting the output to a direct-writing recorder through a jack provided on the back panel. Overall size of the indicator unit is $6\frac{3}{4}$ by $7\frac{1}{2}$ by 5 in. and power is supplied by two 9-v batteries. Brush Instruments Div., Clevite Corp., 37th & Perkins Ave., Cleveland 14, Ohio.

Circle 598 on Page 19



Circle 371 on Page 19

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by John D. Vandenberg and C. Thomas Goldsmith

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The Reeves Motor Pulley is compact,

easy to maintain and economical. It uses a variable pitch pulley and sliding motor base to do the job of expensive gearing or complicated electrical devices, and the motor pulley gives good repeat accuracy on speed changes.

The condensed specification table below gives the standard outside limits of Reeves Vari-Speed Motor Pulley performance. For detailed data contact your nearest Reliance Representative or write for Catalog G-101.

*Consumer net price, including sliding motor base, Reeves variable pitch pulley and drive belt.

MOTOR PULLEY SELECTION 3 to 1 Speed Range

(1800 rpm. motor)

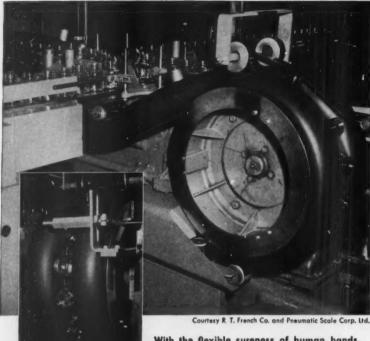
Horsepower (at maximum speed)	1/2	3/4	1 or 1½	2	3	5	7½ or 10	15
Available Driven Output Speeds	1670 to 210 rpm	1515 to 200 rpm	1870 to 245 rpm	1545 to 195 rpm	1435 to 210 rpm	1560 to 225 rpm	1560 to 235 rpm	1065 to 375 rpm
Motor Pulley Diameter (minimum speed setting)	51/2"	6"	7½"	8"	91/2"	10"	12"	12"
Motor Pulley Size Number	95	96	97	98	99	910	912	912-15

For quick delivery see your local distributor-check the Yellow Pages, Power Transmission Section.

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 28-6, CLEVELAND 17, OHIO • Canadian Division: Toronto, Ont.

G-1692



With the flexible sureness of human hands, parallel rubber tubes on this automated machine carry mustard jars through cleaning process in one of R. T. French's modern plants.

Pneumatic Rubber Tubes Solve Delicate Handling Problem

Guided by two large pulleys a pair of lightly inflated rubber tubes pick up glass jars from a flat conveyor at the rate of 240 per minute. With a cushion grip that conforms to these irregularly shaped containers the rubber tubes invert the jars and, without ever dropping one, carry them over jets of 60-psi air for scrupulous cleaning.

The success of this unique device depends on ability of the tubes to hold each jar with uniform, safe tension. To do this, the rubber tubes must retain their given size, shape and resilience while constantly stretching and flexing. Superior impermeability is also essential to prevent any dissipation of air even after long periods of use. Furthermore, the tubes must not kink or collapse when taking relatively sharp turns, especially with the thin tube wall and large cross section.

To save the customer extra equipment costs, the "stretch" of the compound was prefigured so that the manufacturing size would inflate to the proper working size without adjustments.

These exacting specifications require a precise blend of synthetics, processed and cured with the expert techniques of rubber specialists to assure a practical, functional rubber compound of exceptionally long working life.

This is another example of the complete engineering, laboratory and manufacturing service given to rubber parts produced by Continental. Next time your product calls for rubber parts, consult Continental—use this specialized help to save both tooling and material costs and still get rubber components that are practical, functional and dependable.

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THE ENGINEER'S

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Recent Books

Engineered Castings. By Glenn J. Cook; 240 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co., 330 West 42nd St., New York 36, N. Y.; available from MacHine Design, \$8.50 per copy postpaid.

A comprehensive guide is presented for design, application, and purchase of engineered castings. Practical data and facts on modern metal castings are given, including reliability tables on design features, complexity of parts, maximum and minimum size, mechanical properties, precision and tolerances, special structural characteristics and surface detail and smoothness. Discussions are also provided on newer techniques in investment shell processes and induction stirring in arc furnaces.

Institute in Technical and Industrial Communications, 1960 Proceedings. Edited by Herman M. Weisman, Roy C. Nelson, and F. Floyd Shoemaker; 121 pages, 8½ by 11 in., paperbound; published by Institute in Technical and Industrial Communications, Colorado State University, Fort Collins, Colorado; \$5.00 per copy.

Various aspects of technical and industrial communications are surveyed in sixteen papers presented at the 1960 Conference. Specific topics include the technical and scientific report, the communications process, philosophy of science, discussion methods for the technical publication, writing to government specifications and automated scientific communication techniques.

Tunnel Diode Manual. By H. R. Lowry, J. Giorgis, E. Gottlieb, and R. C. Weischedel; 96 pages, 5½ by 8½ in., paperbound; published by General Electric Co., Kelley Bldg., Liverpool, N. Y.; \$1.00 per copy.

This manual is a reference source for circuit design application of the tunnel diode—newest of the semiconductor devices. Information is given on the general theory includ-



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ing the tunnel effect, tunnel diode junction and backward diode. Various applications in logic and test circuits, switches, and oscillators are presented as well as complete specification data.

An Introduction to the Theory and Practice of Transistors. By J. R. Tillman and F. F. Roberts. 340 pages, 51/2 by 81/2 in., clothbound; published by John Wiley & Sons Inc., 440 Park Ave. South, New York 16, N. Y.; available from MACHINE Design; \$8.00 per copy postpaid.

The basic physical theory of semiconductors and the transistor is presented in Part 1 which includes wave-mechanics of electrons in a crystal, nature of ordinary donor and acceptor states, mobility of the carriers, steady-state lifetimes, large signal transient lifetimes, the p-n junction and the minority carrier junction transistor. Properties and applications are presented in Part 2 including point-contact diodes, junction techniques and devices, pointcontact transistors, junction transistors, small-signal amplifiers, feedback oscillators, and switching circuits. Illustrative examples are given for circuit design in the fields of amplification, oscillation, switching, logic, and wave-form generation.

Government Publications

OTS Technical Reports. Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

TN D-767. Simultaneous Least-Squares Approximation of a Function and its Integrals with Application to Thermodynamic Data, By Frank J. Zeleznik and Sanford Gordon, Lewis Research Center; 17 pages, 7% by 10% in., paperbound, staplef; 30.75 per copy.

A method is presented for simultaneous least-squares approximation of a function and its first integrals. This method is applied to fitting empirical equations to heat capacity, enthalpy, and entropy.

NEL Report 5521. Minimum Toughness Re-

NRL Report 5521. Minimum Toughness Requirements for High-Strength Sheet Steel. By J. A. Kies, H. L. Smith, H. Romine, and H. Bernstein, U. S. Naval Research Laboratory; 18 pages, 8 by 10½ in., paperbound; \$0.75 per conv.

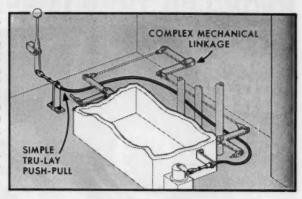
Minimum toughness requirements for high-Minimum toughness requirements for high-strength steels are discussed in terms of an assumed flaw or crack. A quality factor rating for steel—the ratio of strength to weight—is suggested. This factor would reflect the ad-vantages of low density, high yield strength, high toughness, and high modulus.

high toughness, and high modulus.

TN D-750, Local Buckling of Longitudinally
Stiffened Curved Plates, By James P. Peterson
and Ralph O. Whitley, Langley Research Center; 20 pages, 7% by 10½ in., paperbound,
stapled; 80.50 per copy.
Design information is presented on the buckling strength of longitudinally stiffened curved
plates. Charts for determining the buckling
strength of flat plates stiffened by Z-section
stringers are also given. A semiempirical procedure is suggested for determining the effect
of curvature on buckling strength of plates.

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Control Dimension	Minimum Recommended Radius in Inches	Maximum Input Load in Pounds (Dependent on Travel)
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1/8"	3	65-125
3/16"	5	115-175
1/4"	6	300-600
5/16"	8	700-1,000



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Simplified Vibration Analysis by Mobility and Impedance Methods, by R. P. Thorn & A. H. Church, 1959-60 (80 pp.) \$2
Inside the Engineer, by Eugene Raudsepp, 1958-1960 (52 pp.) \$1
Mobility of Cross-Country Vehicles, by M. G. Bekker, 1959-1960 (32 pp.) \$1
Engineering Approach to Hydraulic Lines, by Jaroslav J. Taborek, 1959 (36 pp.) \$1
Planning New Products, by Philip Marvin, 1953-1958 (102 pp.) \$3
Friction-Cluch Transmissions, by Z. J. Zania, 1958 (30 pp.) \$1
Design Guide—Flexible Couplings, by Leo F. Spector, 1958 (128 pp.) \$1
Special Report on Electric Motors, Staff Report, 1958 (42 pp.) \$1
Electronic and Electric Power Supplies, (Symposium) 1958 (40 pp.) \$1
Human-Factors Engineering, by J. D. Vandenburg and C. T. Goldsmith, 1958 (32 pp.) \$1
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1956 (114 pp.) \$2 Transactions of the Mechanisms Conferences

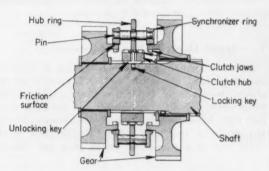
First Conference, 1950 (152 pp.) \$2 Fifth Conference, 1958 (240 pp.) \$3 Fourth Conference, 1957 (104 pp.) \$2 Third Conference, 1956 (40 pp.) \$1 Second Conference, 1954 (50 pp.) \$1 First Conference, 1953 (48 pp.) \$1

Tips and Techniques Vol. 1-Drafting Aids, 1956-1957 (32 pp.) \$1 Vol. 2—Engineering Aids, 1956-1957 (30 NOTEWORTHY

Patents

Positive-Locking Clutch Assembly

A centrifugally actuated key locks a shaft-clutch assembly in engaged position after synchronous speed has been attained. A synchronizer assembly is mounted within a radial extension of the clutch hub which is splined to the transmission shaft. When this assembly is moved to the left or right through a hub ring, the friction surfaces of the synchronizer ring engage mat-



ing friction surfaces on a gear mounted to rotate freely on the shaft. After synchronous speed is attained, further axial movement of the synchronizer assembly causes jaw teeth of the clutch hub to mesh with teeth on the gear. In this position, the centrifugally actuated key is free to move radially outward to positively lock the assembly against axial motion. To disengage the clutch, an unlocking key on the clutch hub is fitted with wedge surfaces which force the locking key to a retracted position in the shaft when the synchronizer-and-clutch assembly is returned to neutral position. Patent 2,978,083 assigned to Clark Equipment Co., by Lewis E. Henyon.

Selective power take-off comprises a single power shaft which has a 6-tooth spline at one end and a 21-tooth spline at the opposite end. The shaft assembly is adapted to conform to either the old (540 rpm) or new (1000 rpm) industry standards. The spline arrangement permits reversal of the shaft position between two output shafts to meet specific assembly and operating requirements. Patent 2,975,643 assigned to Deere & Co., Moline, Ill., by Henry A. Ferguson.

High-Speed Pinion Assembly

In a gas turbine, excessive tooth loads between a high-speed pinion and gear wheel are eliminated by permitting the rotor shaft to rotate about its own mass center. With high-speed rotation any shaft unbalance No Tooling Cost
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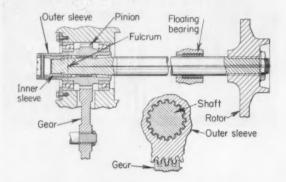
also carbon steel and aluminum. Take advantage of our more than 50 years' experience in metalworking. Without obligation, send your inquiry to the Contract Department.



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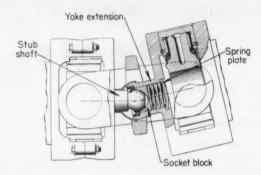
causes the rotor to oscillate. This oscillation deflects the shaft axis which moves along a path in the form of a cone. The apex of the cone is located at a fulcrum point at the center of the left sleeve bearing. Relative movement between the shaft and pinion are taken



up by a spline and sleeve assembly. Since the pinion is isolated from shaft oscillation, its teeth remain concentric with the gear wheel at all times. Patent 2,978,-885 assigned to Orenda Engines Ltd., Malton, Ontario, Canada, by Roger Alan Davison.

Wear-Compensating Universal Joint

In a double-universal joint, vibration and noise resulting from wear of parts are eliminated by springloaded socket blocks. The blocks are free to slide within a tubular extension of the yoke, and are dimensioned



to provide line contact near the greatest diameter of the ball to minimize stress. The spring is retained by a plate secured in an annular groove in the yoke. Patent 2,978,886 assigned to General Motors Corp., Detroit, Mich., by Donald P. Marquis.

Two-Speed Linear-Motion Mechanism

Linear motion of a reactor safety plug is controlled by a two-speed screw mechanism. Control is accomplished by an inner and outer screw assembly. The inner screw has left-hand threads and the outer screw has right-hand threads. Screws are rotated through gearing by a reversible motor. Air supplied to the lower end of the cylinder moves plug and follower



FROM STEM TO STERN RIVNUTS' SIMPLIFY ASSEMBLY

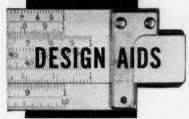
RIVNUTS perform three different fastening jobs in this sleek boat manufactured by Superglas Corporation, Nashville, Tennessee. The three applications are all "blind"—thus RIVNUTS, which can be quickly installed from the exterior, simplify assembly and save production time. In addition,

fastening is strong and vibration proof. For complete information on how RIVNUTS can improve your fastening operations write for copy of RIVNUT Data Book. Dept. MD-6, B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Akron, Ohio. In Canada: Kitchener, Ontario.



2

Fractional Horsepower Motors



Lamb Thinking on Universal Motors for a unique actuator application

Here's what Lamb Electric designed into these motors:

In order to obtain the required speed and torques and retain the most economical and smallest package, a combination worm and spur gear reduction was used. Also, because of the peculiar space limitations in the application, special design considerations had to be given to the gear ratios and mechanical layout of the package.

In the initial stages of the design a motor was provided which met the specified speed and torque requirements, however it was soon discovered that this design overheated rapidly. Analysis of the first prototype tests showed that the load cycle had a particularly high torque peak for a very short duration. The motor was designed to supply this amount of torque near its stalled speed. It was found that by taking advantage of the accelerating rate and starting torque of a universal motor, the motor accelerated quickly enough to provide sufficient inertial energy to complete the duty cycle. This enabled the engineers to redesign for a lower peak horsepower output and obtain reasonable operating temperatures, thus producing the minimum size package consistent with the torque and temperature requirements.

The application was such that severe shock loading was encountered at a certain point in the duty cycle. In order to make mechanical construction that would withstand this service, ductile iron castings were furnished and special consideration had to be given to the overhung moment of the motor-gear unit to insure against damage due to vibration. Special bearings had to be used in this service because Brinnelling would occur on normal ball bearings under the severe service encountered. Lubrication is generally a problem under this short duty cycle, therefore, special consideration had to be given to insure that the lubricant protected the wearing surfaces at all times.

This is just a short example of Lamb at work . . . if you have a motor problem, let us help you with it. This is our business. Write: Lamb Electric, Kent, Ohio, and we'll have a Lamb District Engineer call on you to open preliminary discussion of your problem.



THE LATEST DESIGN NEWS ON FHP MOTORS FROM LAMB ELECTRIC



New Lamb motors represent advancements in small universal motor design

New design combines high quality and long life with relatively low manufacturing costs

Initially, the I.S. 15028 and companion motor I.S. 14926 were designed for powering rug agitators on a well-known line of canister-type vacuum cleaners. Now, many future appliance applications have been visualized. The range of ratings possible with this design (as high as 1/10 H.P. at 12000 RPM or ½ H.P. at 15000 RPM) makes this motor ideally suited for many motor powered domestic applications.

Some of the novel features of this motor project were:

The housing is a one-piece simple phenolic molding. It is designed in a half shell form in such a way that the motor bearings and other components can be held in accurate relationship with an unmachined housing.

The half shell housing of the motor is designed to mate with a corresponding opening on the customer's device to complete the motor enclosure. When a free standing motor is desired, this upper enclosure can be a simple stamping.

The I.S. 15028 motor was designed with a sleeve and a ball bearing. However, on other versions of this motor, either sleeve or ball bearings or a combination can be used at only a low tooling expense through use of easily interchanged inserts in the housing mold cavity.

The sleeve bearing as used in this design takes full advantage of the economics possible with the half shell motor design. The full-spherical shaped self-aligning type of sintered bearing is mounted directly in a semi-spherical recess in the housing. A spring clip presses against the top of the bearing to secure it in place while at the same time permitting self-alignment movement. Life-time lubrication is provided by an oil soaked felt strip located beneath the bearing. There are other features worth noting in this unique design problem. For further particulars, write to Lamb Electric Co., Kent, Ohio.



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Circle 382 on Page 19



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"Spun End" construction allows the placement of maximum metal thickness at end plate bore reducing unit pressures of radial loads while providing thin plate flexibility to accommodate shaft deflections.

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stretch and wear—while
increasing belt training
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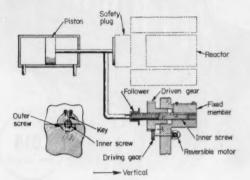
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Circle 381 on Page 19

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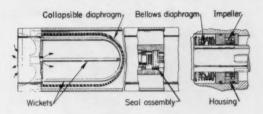
upward until the follower base butts against the base of the inner screw. Plug continues upward at relatively high speed until the follower flange butts the outer screw. Further motion to final position is then at



relatively low speed of the outer screw. Patent 2,977,814 assigned to the United States of America as represented by the United States Atomic Energy Commission, by Glenn S. Brunson Jr.

Submerged Motor Sealing System

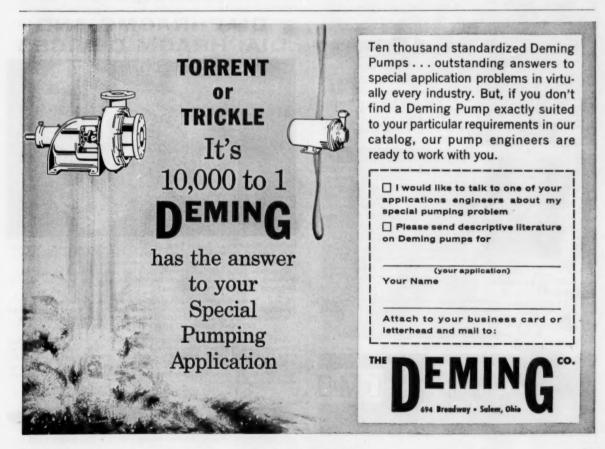
An impeller built into a submersible pump seal assembly provides a pressure barrier to prevent the escape of protective oil from within the motor casing. A housing which encloses the impeller is fitted with an annular pumping chamber. As oil expands from increased motor temperature the resulting pressure flow through the seal is opposed by the pressure developed by the impeller within the annular chamber. The impeller is dimensioned to develop the proper degree of centrifugal force to prevent counter flow through the seal. A large



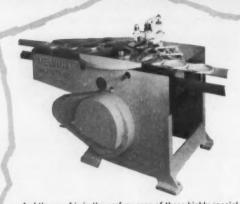
diaphragm seal, reinforced by a wicket structure, accommodates the change in oil volume. Patent 2,979,347 assigned to Reda Pump Co., Bartlesville, Okla., by Armais Arutunoff.

Quick Release Flange Assembly

An accessory is rapidly mounted to or detached from an engine support pad with a quick-disconnect flange-joint design. The engine flange is fitted with a notched pin which engages a shoulder in the ac-



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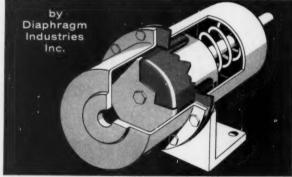
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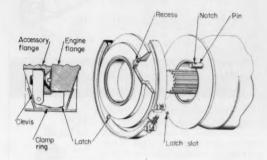
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cessory flange when the accessory is pushed into place on the pin and partially rotated. In this position, a latch at the bottom of the accessory flange is engaged with the engine flange to prevent further rotation. Both flanges, which have tapered outer surfaces, are then

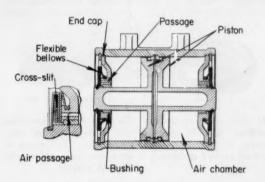


drawn together by a split clamp ring to lock the assembly in mounted position. Patent 2,978,265 assigned to The Garrett Corp., Los Angeles, Calif., by Harold E. Cluff.

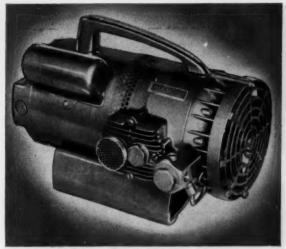
Hydraulically actuated circuit breaker is controlled by a control valve of the poppet type, requiring only a single pilot valve for effecting high-speed opening and closing. Pressure relief on the hydraulic motor is accomplished at the end of closing stroke as soon as valve motion begins. Patent 2,972,337 assigned to General Electric Co., New York, N. Y., by Thelwell R. Coggeshal and Ugo R. Tognella.

Air Breathing Bellows Seal

Cross-slits in two flexible rubber bellows permit air-breathing from and into the air chambers in a duplex power cylinder. Each bellows is interconnected between the end cap and related piston rod to protect



rod and piston from contaminating elements. As the piston moves outward, air is expelled from the air chamber through a passage in the end cap and cross-slit in the bellows; air flow is reversed as the pistons move inward. Patent 2,979,906 assigned to American Steel Foundries, Chicago, Ill., by George A. Lindstrom.



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Patent Applied For

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SPEAKING OF



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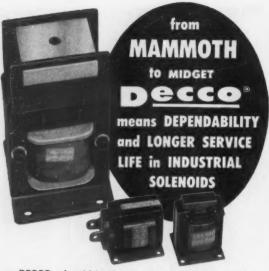
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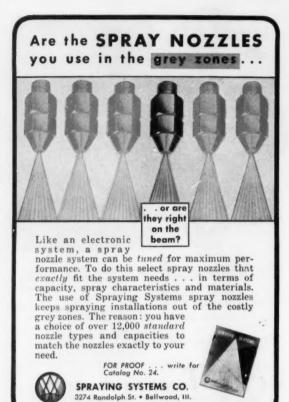


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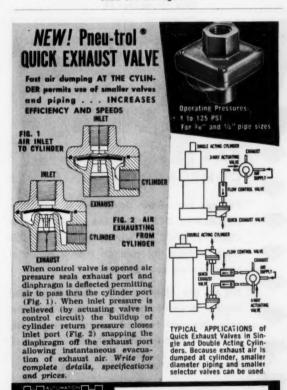


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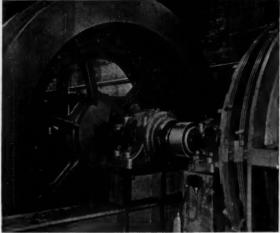




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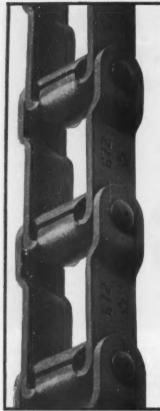


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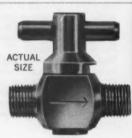
degrees from full-on to full-off. "O"-Ring seals virtually eliminate

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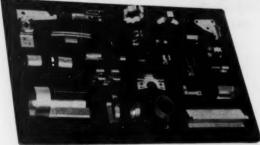
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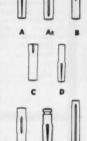
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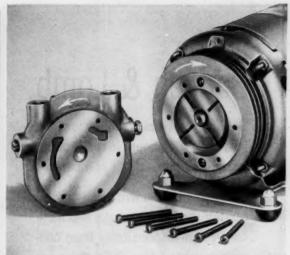
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Circle 409 on Page 19

ENGINEERS

WANTED: Standards Engineer. For a high precision magnetic tape recorder manufacturer in the San Francisco Bay area. BSME or BSEE plus five years experience in designing, fabrication and quality control. Will be responsible for planning Standards activity, and coordinating Standards among the divisions. Must have perceptive personality and cooling the divisions. ability to command the confidence of colleagues in technical areas. Send resume to Mr. Fred Schlaepfer, Ampex Corporation, 2400 Bay Road, Redwood City, California.

WANTED: Design Engineer. For a high precision, magnetic tape recorder manufacturer in the San Francisco Bay area. BSME plus eight years machine design experience. Will be responsible for creating complete designs of systems based on engineering specifications. This includes complete layout and general arrangement drawings, strength of materials computations, selection of materials and determination of production methods and processes. Also will co-ordinate design details with value reliability and service engineering. Send resume to Mr. Fred Schlaepfer. Ampex Corporation, 2400 Bay Road, Redwood City, California.

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MARY L. CALLAHAN Advertising Service Mane

BARBARA O'LEARY Reader Service Manager

AMY LOMBARDO Circulation Manager

ROBERT E. LESSING Production Manager

District Offices

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Dresher (Philadelphia), Pa.1335 Harris Rd. CHANDLER C. HENLEY, Mitchell 6-2585

Cleveland 13Penton Bidg. JACK W. WALTON, DON J. BILLINGS Main 1-8260

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Chicago 11

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Dallas 35525 Exchange Bank Bidg. JAMES H. CASH, Fleetwood 1-4523

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AUTOMATION

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backtalk-

- Solid-State Cardsharp?

An expert poker player (left) beats the average gambler and breaks even with good players. This is the report of David Dewan, a Niskayuna, N. Y., high school senior, who built the electronic computer he calls Pokerac. It specializes in two-handed, five-card draw,



with no cards wild. When cards are offered to Pokerac, lights indicate what it wants to keep; it shows its hand by means of a light next to the appropriate term.

David spent 300 hours building Pokerac, after making 1000 calculations on probability values. While we admire the machine, we're putting our money on David—anybody who knows that much about poker is very likely to succeed.

- The Wild Blue Future

Everybody knows what jets are, but do you know what JETS is?

The Junior Engineering Technical Society, with 650 chapters in 43 states and several foreign countries, provides contact between high school science students and real live engineers and scientists. To quote the Engineers Joint Council's Engineer, the JETS program "serves as a co-operative effort through which industry, engineering and scientific societies, and educational institutions may work together to

enhance the science and engineering programs in their local high schools. It combines the assistance and guidance of professional men, actively engaged in the science and engineering fields [that's you] with classroom activity under the guidance of high school instructors..."

You can learn more about the organization by writing to JETS, Box 589, East Lansing, Mich.

Financial Feedback

Although we receive thousands of cards and letters from readers asking for copies of and commenting on articles that appear in Machine Design, we don't hear much from authors after publication. This is a good sign, because it means that all's well and the author is happy with the way his words look in print.

Here, however, is a pictorial sequel, furnished by the General Electric Co., to John Campbell's



article on "Fractional-Horsepower Motors," which appeared in our May 11 and May 25 issues. That's John on the right, receiving our \$275 honorarium in a presentation by Bill Boggess, GE's General Purpose Motor Dept. manager of marketing. In the middle is Ken Whearley, manager of sales. (GE ran the picture in its Fort Wayne Works newspaper to encourage article writing.) John Campbell was surprised and pleased to receive this check for Part I of his article and, we assume, was similarly affected by the matching check for Part II.

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RULOR FILOR

RULON'S "Plastic Memory" Means Tighter Seals . . . Lower Costs

RULON (reinforced TFE) parts
post-formed from tape are ideal for
seals, packings, rings, etc. because
they exhibit no stick-slip and greatly
reduce starting torque. And unlike
rubber or leather,
RULON takes any
hydraulic fluid – and

rubber or leather, RULON takes any hydraulic fluid – and its plastic memory insures positive contact with shafts or cylinder walls. Parts have infinite shelf life, too – completely un affected by weather, light or heat.

Dixon's self-lubricating RULON gives your sealing applications all the advantages of Teflon – low friction, chemical inertness, zero moisture absorption, ex-

treme temperature range (-400 to +500°F) - PLUS a tremendous increase in mechanical strength and wear resistance.

Next time, look at your design with RULON in mind. This material is now available with improved sealing action and at costs competitive with leather and rubber. For complete data on stamped or postformed parts . . . special reinforced fluorocarbons for special needs . . . and a wide selection of basic shapes in both RULON and Teflon . . . see our Catalog in Sweet's Product

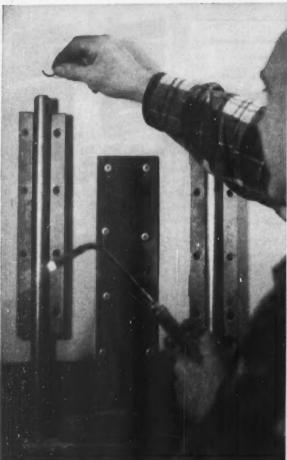
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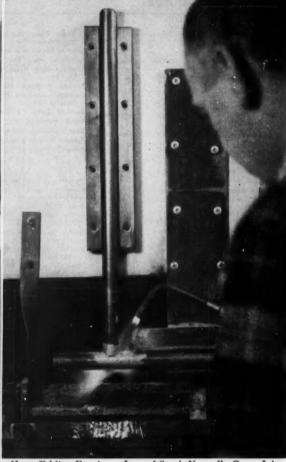


DuPont T.M.



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Joining tubular members is easy for Howe Folding Furniture, Inc., of South Norwalk, Conn. Joints are fluxed with Handy Flux, a half-circle preform of EASY-FLO brazing alloy is dropped down the tube and a torch is applied. Result: A smooth, strong joint quickly and economically made.

How Handy & Harman Brazing Alloys

GIVE FOLDING FURNITURE 100% JOINT RELIABILITY

The experience of Howe Folding Furniture, Inc., with silver brazing merits close attention if your operations involve metal-to-metal joining of any kind. Howe manufactures folding metal tables and seats for commercial, industrial and institutional use. You can imagine the hard usage the furniture has to take—yet survive indefinitely.

Some years ago, it was Howe's practice to purchase prefabricated steel tubular assemblies in which the joints were brass brazed on the outside surface. To improve their product, Howe thoroughly tested all joining methods, and decided to go over to silver brazing in their own plant, using Handy & Harman EASY-FLO Alloys 45 and 35. Look at the results:

Complete Joint Reliability: Since adopting silver brazing, Howe has completely eliminated the problem of broken joints.

Economy: Silver brazing costs Howe less than other methods, requires less heating time, simpler equipment, much less cleaning and grinding of joints.

Appearance: Silver brazing provides a smoother, more attractive joint, that can

be plated directly.

Is it any wonder Howe says: "We'd stay with silver brazing even if it cost more?" There are few fields of industrial activity where the strength, high production rates and economy afforded by the Handy & Harman family of silver brazing alloys cannot improve the look of the balance sheet. Interested in complete details? Just write for a copy of our Bulletin 20 - it's packed with engineering and application data.



Howe cafeteria table-bench is converted to an auditorium bench with backrest in a single motion. Silver brazed joints easily absorb strains.



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TYPICAL





CLUTCHES & BRAKES

The new revised handbook contains many clutch and brake applications...plus complete catalog information and money-saving industrial uses. WRITE FOR YOUR COPY TODAY!

Circle 202 on Page 19

Since we do not wish to mutilate this fine magazine cover with a reply coupon, we will have to ask you to favor us with a letter for this new Wichita idea book ... you'll find it worth the trouble! Wichita Clutch Company POBOX 1150 Wichita Falls, Texas



DESIGN

C/R offers new bonded CRS Seal design in standard sizes without premium tooling charges











Design Advantages

The CRS Seal now provides a new level of C/R Seal performance through its simple, bonded design. There are no internal parts to misalign, no avenues for internal leakage. The shell and sealing member are integral — bonded securely for the long life of the seal. The CRS Seal incorporates a sealing member with both improved lip configuration and improved concentricity. The sealing member has been strengthened over former designs by placing more material at points of major flex and wear — and without increased shaft loading.

Designer Advantages

The CRS Seal gives the designer one, basic, rugged shaft seal design which may be applied with high reliability to the great majority of common shaft seal applications—particularly in industrial, automotive, farm, and off-the-road equipment.

Four basic design variations are available. As you can see, these provide an auxiliary sealing lip, where it may be required, or provide extra rugged shell construction where conditions suggest the need to protect the seal lip against assembly damage — or where large, heavy-duty shafts are being sealed.

Selection of the new C/R Type CRS Seal gives the designer and buyer major advantages over special seals: shorter lead time on orders, simpler specification, savings in time and money, and improved assembly quality and reliability.

Operating Maximums*

Shaft Speeds 3600 fpm (single lip)
2500 fpm (double lip)
Run-out .015" TIR dynamic
eccentricity

.010" static eccentricity
Temperature -30 to +275°F.

(225°F, in EP lube)
Pressure 5 psi (single lip)

10 psi (double lip)

Media Oil, grease, fuel, water

*Not all conditions present in one application

New, Improved Compound

Standard sealing members for the C/R Type CRS Seal are molded of a new Sirvene synthetic rubber compound having markedly superior sealing and wearing properties. It is a Buna-N-based material with low-friction characteristics. The CRS Seal can also be furnished in the usual special materials such as acrylates, Sili-

cones, and butyls. Shells are of standard steel, but can be provided in corrosionresistant materials on special order.

Consult C/R Engineers

For assistance on the application of the new CRS—or on any oil seal problem, get in touch with C/R Oil Seal Engineers. They're specialists in fluid sealing—and will gladly cooperate with you.

For More Design Data:

You will want the complete design data on the new CRS Seal. Write for our Bulletin CRS-100. It gives you the complete list of standard sizes, widths, O.D.'s, shell thicknesses and sealing lip heights. You will want it to compare and then specify C/R's CRS Seal.

CHICAGO RAWHIDE MANUFACTURING COMPANY

1221 Elston Avenue . Chicago 22, Illinois

Offices in principal cities

See your telephone directory

In Canada: Chicago Rawhide Mfg. Co. of Canada, Ltd., Brantford, Ontario

Export Sales: Geon International Corp., Great Neck, New York

